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# PLUMBING

WILLIAM PATON BUCHAN

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SANITARY ENGINEER AND PRACTICAL PLUMBER

PAST PRESIDENT OF THE SANITARY AND SOCIAL ECONOMY SECTION OF THE PHILOSOPHICAL SOCIETY OF GLASGOW; AND FELLOW OF THE ROYAL SCOTTISH SOCIETY OF ARTS. MEMBER OF THE SOCIETY OF ARTS; AND ASSOCIATE OF THE SANITARY INSTITUTE, LONDON

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# PREFACE.

About the end of 1871 great excitement was occasioned in the sanitary world by the severe attack of typhoid fever which his Royal Highness the Prince of Wales then had. Londesborough House—although it possibly had nothing to do with the origin of the Prince's attack—was turned inside out, so far as its drains and sanitary fittings were concerned, while the papers were filled with all sorts of explanations and suggested improvements. I ventured to criticise some of these remarks at the time in a well-known London weekly journal, the consequence of which was that I was then engaged by the proprietors of the journal referred to—*The Building News*—to write a series of articles upon Plumbing for their paper. This was done, and the series of articles in question formed the basis of the present work, with, of course, considerable modifications and a large quantity of additional matter.

In writing these articles upon Plumbing one especial object kept in view was to afford a Handy Text-book to the apprentice-plumber, to which he could turn for an explanation of the mysteries of his craft, and so understand the object and uses of the various pipes used, their different sizes and positions, &c., &c. I felt the want of such a treatise very much when an apprentice, but turn where I would, I could meet with none, so that I had to set to work and make my own notes the best way possible under the circum-

stances. Now all this was unfair as regards the apprentice-plumber, and unfortunate considering the interests involved, especially when we consider the evil effects liable to be produced by bad Plumbing. The joiner and the mason have had their text-books and literature in abundance, to which they could at any moment turn for information, but not so the Plumber. His craft was still one of the real mysteries, insight to which was only to be obtained by a long probation. This little work will, I hope, supply the *desideratum*, and I shall feel glad should it prove the pioneer of many others of a similar practical kind.

In the new chapters, towards the end, upon Scientific and Safe Water-closets, and an Improved System of House Drainage, it is believed that, so far as the safety *per se* of the house and its inmates are concerned, a practical and simple solution has been found to the scientific theories and problems of such sanitary writers and authorities as Carpenter, Fergus, Gairdner, Latham, Littlejohn, Rawlinson, and Richardson, &c.

Although it was stated above that the principal portion of this work was written with a view to the special edification of the young apprentice-plumber, the hope is indulged that it may be found useful even to architects and medical professors, and also to all having anything to do with sanitary matters, while to many of my brethren in the trade I trust it may prove a useful *vade-mecum*.

21, Renfrew Street, Glasgow,
*June 1st*, 1876.

## PREFACE TO THE SEVENTH EDITION.

It is now about twenty years since the first edition of this book was published, with 279 illustrations in it. Since then other editions have been issued, gradually increasing in size owing to addition of new matter and drawings, so that the illustrations to the last, or sixth edition, numbered about three hundred and eighty.

As a great deal of the extra matter was added in at the end of the book, and away from its proper connection, advantage has been taken of this new edition to alter that by putting back the added matter into its proper chapters, and (while deleting some matter in other chapters, now rendered superfluous in this work, owing to its being included in the work on "Ventilation," No. 275 of Weale's Series) new matter has been introduced, as well as about one hundred and seventy new drawings—making in all now five hundred and twelve illustrations—in order to show the latest improvements in *Sanitary Plumbing practice up to date of publication.*

It is to be hoped, therefore, that this seventh edition of PLUMBING will prove of service not only to the rising generation of plumbers and others interested in improved sanitation, but also to those who possess one or more of the former editions.

GLASGOW,
*January 3rd*, 1896.

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NOTE.—The PUBLISHERS greatly regret to have to record here the death of MR. W. P. BUCHAN, within a few months of his passing for press the proof sheets of the present volume, which is now issued as completed by him in anticipation of the demand for a new edition of his standard TEXT-BOOK OF PLUMBING, and which they feel assured will fully maintain the high reputation the work has so long enjoyed.

LONDON,
*November*, 1896.

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# INTRODUCTION.

THERE are few things in connection with our modern houses of greater interest or more worthy of careful consideration, so far as the comfort and health of the tenants or inmates are concerned, than the character of the plumber's work. The ramifications of the pipes in thousands of cases are now so many and various, and the evil effects of bad work and of bad planning are so often manifested upon those exposed to their baneful influences, that it becomes a question of the highest importance to all concerned—and who is not?—What is the character and condition of your plumber's work? In answer to this question, and in order to throw some little light upon the subject, it is our intention in the following pages to give such information upon the matter as, we trust, may be both useful and interesting.

If we allow the mind to dwell for a moment upon the subject of architecture in stone, three glorious eras rise up before us, in which the genius of the Egyptian, the Greek, and our Mediæval ancestors had scope, and produced grand results, all in consonance with the wants and aspirations of their several ages, and results, too, which it is yet left for the future to excel. It is different, however, with plumbing, for in no past age have its present productions as a whole either been equalled or surpassed.

Of course the mind here may revert to the vast works of the Romans in connection with their water supply; but, apart from other considerations, a distinction must be drawn *between* engineering and plumbing. The present *is the era and grand* opportunity of plumbing, and in order

to bring it to perfection, both the architect and the plumber must work in harmony, and together do whatever in them lies to produce such a result as will be both creditable to them, and a blessing to the community at large.

The noble and now venerable monuments of the past before alluded to, were not produced by magic—modern science having fairly disposed of the brownies or pixies, gnomes, and fairies of our youthful ideas—they were produced by each individual in his own sphere doing well the work that lay to his hand. The smith had to make and sharpen the tools, the mason had to use them, and though they were often only classed and looked upon as "labourers," yet we see what grand results able supervision could cause both the Egyptian slave and the English labourer to produce.

So we said in the first edition of this book, brought out in 1876. Since then the plumbing trade has come through a rare experience. It has been patronised by Parliament, and from a handicraft has been making great strides towards the dignity of a profession. The mere mechanical or rule-of-thumb worker is developing into the educated craftsman whose work is based upon assured theory, and who can give a sensible reason for everything he does. A good plumber may by-and-by be looked upon as a benefactor of humanity.

Plumbing is fitting itself not merely to become the handmaiden of the noblest of the professions, but, when education has further advanced the race, the physician and the plumber may come to be looked upon as brethren, not to the lowering of the dignity of the former, but by raising the qualifications and status of the latter.

# PLUMBING.

## CHAPTER I.

### PLUMBERS' MATERIALS.

"PLUMBING," the art or handicraft of the plumber, is derived from the Latin word *plumbum*, lead; while "plumber," strictly speaking, is one who works in or with lead. Few, if any plumbers nowadays confine themselves to lead. In fact, for general plumber's work, none can, for the *solder* used in joining lead pipes, &c., &c., together is a composition of two metals, viz., of lead and tin. Sometimes a third, zinc, gets slipping in somehow, generally surreptitiously, but its presence in the solder pot is as pleasant and useful as that of the bull in a china shop. A metallic compound which the plumber largely uses, and in which zinc may legitimately make its appearance, is brass. Brass, *i.e.* yellow brass, is an *alloy* of the two metals copper and zinc, in the proportion of 8 oz. of zinc to the lb. of copper. Sometimes a little lead is added, say 1 oz. of lead to 5 lb. of copper, in order to make the brass softer and easier to work. The value of this softness in the afterwear is questionable, however. Gun-metal brass, or bronze, is composed of copper and tin in various proportions according to its intended use. For cannon 9 lbs. of copper to 1 lb. of tin, for bushes 8 of copper to 1 of tin, for house bells 4 of copper to 1 of tin, for stop-cocks and valves 44 copper, 5 zinc and 1 tin.

A plumber's brassfounder says he uses crucibles to hold about 50lbs. of metal. He first puts in about, say, 30lbs. of copper and allows it to get melted and up to a proper heat, which, if the furnace is hot when the crucible and copper were put in, may require 1½ or 2 hours. Then a quarter of an

hour before casting the brassfounder puts in his alloy—for gun metal 2 oz. of tin and 2 oz. of lead to the lb. of copper if the alloy is for water cranes. If it is for hard bush metal the lead is omitted and 3 oz. of tin to the lb. of copper put in. Sometimes 2 oz. of tin and 1 oz. of lead to the lb. of copper may be used, but the alloy is softer then.

Copper, as will be referred to farther on, is also used for pipes, and as sheet copper, and the same with tin. Zinc is also used in the shape of sheets, while iron is employed in many ways, as for pipes, gutters, ridges, &c. Both iron and copper are utilised in the manufacture of the plumber's tools. Even silver, as plating, makes its appearance in many of the better class of plumbing jobs, especially of late years. Lead has been the principal material with which the plumber worked until about the middle of the present century, when other metals or materials largely usurped its place, and often ousted it from many places or situations where it formerly reigned supreme. Notwithstanding all this the quantity of lead still used by plumbers in their work, both on the outside and in the inside of buildings, is still great.

On account of its nature and applicability it is difficult to supplant lead with anything better for many purposes, and especially at less cost. The plumber of to-day, while also using other metals in the course of his work, has yet to be largely a lead worker, and unless he can handle this metal properly his title to the old and honourable designation of "plumber" will be apt to be called in question.

The plumbing craft existed not only in Rome coeval with the Cæsars, but also in Babylon long before, and anterior to either in Egypt as far back as the reign of Menes, about 5,000 years B.C.* Among the finds discovered in the Lake Dwellings of Central Europe, crucibles for melting metals have been found. All this tends to show the high antiquity of the use of metals by man. Stone or flint implements were common thousands of years prior to the introduction of metals.†

As a metal lead (chemical symbol Pb.) is comparatively

* In the song attributed to Moses, Exodus xv. 10, lead is mentioned. Also in Numbers xxxi. 22, and Job xix. 24, &c., but these comparatively recent references to its use.

† In this connection see "Human Origins," by Samuel Laing, published by Chapman and Hall, London.

soft, and is one of the heavier metals coming after iridium, platina, gold, tungsten, palladium, and mercury. Taking a cubic foot of water at 40° Fahr. as 1000 oz. avoirdupois, the specific gravity of lead is 11·352, or 11,352 oz. to the cubic foot. That is to say that lead is eleven and one-third times heavier than water. Its colour is greyish, or a sort of bluish white, with a metallic lustre. Clean lead is even brilliant, but it soon gets tarnished by exposure to the atmosphere or to damp in consequence of the formation of a thin film of oxide on its surface. Being durable, easily fusible, flexible, malleable and plastic, lead can be used for a large variety of purposes.

When exposed to the air during fusion lead oxidizes, and so is styled a base metal. Gold, platinum and silver do not oxidize when so exposed but remain bright, and hence are designated noble metals.

Lead is obtained from lead ore, or sulphide of lead, a mixture of sulphur and lead otherwise named Galena. This mineral Galena when pure is composed of 13·3 parts of sulphur to 86 of lead according to Chambers, or 86·55 of lead to 13·45 of sulphur according to other authorities. Silver is often found in the lead, sometimes in considerable quantities. Maguire says from 2 oz. per ton up to—in the mines of Colorado—as much as 800 oz. per ton. Copper, zinc, and antimony are also found mixed with it. For the plumber's general use lead as pure as possible is preferable. Hard lead implies adulteration. When the silver amounts to 4 oz. or even less in the ton it is separated from the lead either by Pattinson's process, or by Kartin's more recent improvement upon it.

Lead mining is carried on at various places in England, especially in Derbyshire and the North, also in Cornwall in the South. Likewise in the Isle of Man and at Leadhills in Scotland. No doubt the Romans were acquainted with and worked some of these mines. In Europe, however, Spain produces the most lead. P. J. Davies, quoting from Herr Landsberg, gives the following estimate for the year 1881:—Spain, 120,000 metric tons; Germany, 90,000; England, 67,000; France, 15,000; Italy, 10,000; Greece, 9,000; Belgium, 8,000; Austria, 6,000; Russia, 1,500; while the output of the United States of America is put at 110,000 tons. Since then Australasia has furnished a large quantity of lead, the amount in 1893 being 56,644 tons.

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Copper, as will be referred to farther on, is also used for pipes, and as sheet copper, and the same with tin. Zinc is also used in the shape of sheets, while iron is employed in many ways, as for pipes, gutters, ridges, &c. Both iron and copper are utilised in the manufacture of the plumber's tools. Even silver, as plating, makes its appearance in many of the better class of plumbing jobs, especially of late years. Lead has been the principal material with which the plumber worked until about the middle of the present century, when other metals or materials largely usurped its place, and often ousted it from many places or situations where it formerly reigned supreme. Notwithstanding all this the quantity of lead still used by plumbers in their work, both on the outside and in the inside of buildings, is still great.

On account of its nature and applicability it is difficult to supplant lead with anything better for many purposes, and especially at less cost. The plumber of to-day, while also using other metals in the course of his work, has yet to be largely a lead worker, and unless he can handle this metal properly his title to the old and honourable designation of "plumber" will be apt to be called in question.

The plumbing craft existed not only in Rome coeval with the Cæsars, but also in Babylon long before, and anterior to either in Egypt as far back as the reign of Menes, about 5,000 years B.C.* Among the finds discovered in the Lake Dwellings of Central Europe, crucibles for melting metals have been found. All this tends to show the high antiquity of the use of metals by man. Stone or flint implements were common thousands of years prior to the introduction of metals.†

As a metal lead (chemical symbol Pb.) is comparatively

* In the song attributed to Moses, Exodus xv. 10, lead is mentioned. Also in Numbers xxxi. 22, and Job xix. 24, &c., but these *are* comparatively recent references to its use.

† *In this connection* see "Human Origins," by Samuel Laing, *published by Chapman* and Hall, London.

soft, and is one of the heavier metals coming after iridium, platina, gold, tungsten, palladium, and mercury. Taking a cubic foot of water at 40° Fahr. as 1000 oz. avoirdupois, the specific gravity of lead is 11·352, or 11,352 oz. to the cubic foot. That is to say that lead is eleven and one-third times heavier than water. Its colour is greyish, or a sort of bluish white, with a metallic lustre. Clean lead is even brilliant, but it soon gets tarnished by exposure to the atmosphere or to damp in consequence of the formation of a thin film of oxide on its surface. Being durable, easily fusible, flexible, malleable and plastic, lead can be used for a large variety of purposes.

When exposed to the air during fusion lead oxidizes, and so is styled a base metal. Gold, platinum and silver do not oxidize when so exposed but remain bright, and hence are designated noble metals.

Lead is obtained from lead ore, or sulphide of lead, a mixture of sulphur and lead otherwise named Galena. This mineral Galena when pure is composed of 13·3 parts of sulphur to 86 of lead according to Chambers, or 86·55 of lead to 13·45 of sulphur according to other authorities. Silver is often found in the lead, sometimes in considerable quantities. Maguire says from 2 oz. per ton up to—in the mines of Colorado—as much as 800 oz. per ton. Copper, zinc, and antimony are also found mixed with it. For the plumber's general use lead as pure as possible is preferable. Hard lead implies adulteration. When the silver amounts to 4 oz. or even less in the ton it is separated from the lead either by Pattinson's process, or by Kartin's more recent improvement upon it.

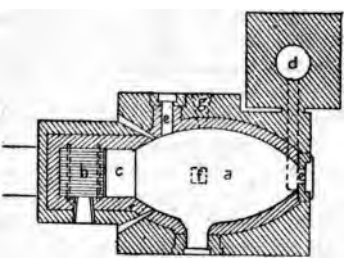
Lead mining is carried on at various places in England, especially in Derbyshire and the North, also in Cornwall in the South. Likewise in the Isle of Man and at Leadhills in Scotland. No doubt the Romans were acquainted with and worked some of these mines. In Europe, however, Spain produces the most lead. P. J. Davies, quoting from Herr Landsberg, gives the following estimate for the year 1881:—Spain, 120,000 metric tons; Germany, 90,000; England, 67,000; France, 15,000; Italy, 10,000; Greece, 9,000; Belgium, 8,000; Austria, 6,000; Russia, 1,500; while the output of the United States of America is put at 110,000 tons. Since then Australasia has furnished a large quantity of lead, the amount in 1893 being 56,644 tons.

The imports and exports of lead for the years 1891-1893, according to Board of Trade returns, were :—

| | | 1891. | 1892. | 1893. |
|---|---|---|---|---|
| Imports . . | tons | 169,724 | 182,782 | 191,174 |
| Exports . . | ,, | 48,233 | 58,162 | 48,935 |

In December, 1893, we imported from Germany 597 tons, from Spain 7,790 tons, from Greece 1,785 tons, or about double average quantities, from Australasia 4,047 tons, from other countries 2,949 tons.

When the lead ore or Galena is taken from the mine, it



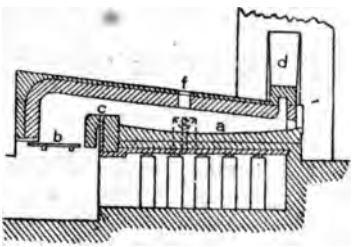

PLAN OF REVERBERATORY LEAD FURNACE.—*a*, Hearth on which the ore is spread ; *b*, Fire-place ; *c*, the Fire-bridge ; *d*, Chimney ; *e*, Working Doors ; *f*, Opening for Supply in Grate ; *g*, Tap-hole.

Fig. 1.

is broken up into small pieces and washed. It is then put into a reverberatory furnace, about one or two tons or so at a time, to be roasted, and either with or without lime. In about two hours' time the charge is roasted. During this process the larger portion of the ore (Pbs.) takes up four equivalents of oxygen, and becomes sulphate of lead (Pbo, $SO_3$), a little oxide of lead (Pbo) is also formed, while another portion remains unaltered as sulphide of lead. After it is roasted, the ore is thoroughly mixed together, and the heat of the furnace suddenly raised This causes a reaction between the unchanged and the oxidized portion of the ore, and reduces much of the lead, sulphureous acid being at the same time evolved. In the third stage, lime is thrown in and mixed with slag and reduced ore. When this becomes acted on, the whole of the lead is practically *separated from the ore,* and is then run off at the tap-hole.

Figs. 1 and 2 give plan and longitudinal and vertical section of a Reverberatory Lead Furnace as illustrated in Chambers's Encyclopædia (ed. 1874).

During the smelting process a quantity of the lead is volatilised, and carried off as *fume* or *smoke*, which, when allowed to escape into the atmosphere, not only involves loss of heat, but also destruction of the vegetation in the




SECTION OF FURNACE.

**Fig. 2.**

neighbourhood, as well as poisoning the cattle and other animals feeding near. One cure for this is to carry the smoke and fumes from the furnaces through a long horizontal flue—perhaps a mile in length—to a vertical stalk, when the fume condenses on the side, and may be collected. About 33 per cent. of the fume recovered consists, it is stated, of metallic lead.*

* "Chambers's Encyclopædia."

## CHAPTER II.

### PLUMBERS' TOOLS.

PREPARATORY to beginning work, the plumber has to provide himself with tools. On page 9, an illustration is given of the sort of tools required. Of some of these, such as hammer, ladle, file, dresser, shave-hook, soldering-iron, it is useful or necessary to have more than one.

1. Copper-bit—hatchet shape.
2. Copper-bit—straight.
3. Hammer.
4. Cold-chisel.
5. Screwdriver.
6. Coupling-plyers.
7. Wire-plyers.
8. Ladle.
9. Soldering Cloth, different sizes, used to suit size of joints.
10. Pocket-knife.
11. Foot-rule.
12. Gouge.
13. Wood Chisel.
14. Awl or Brog.
15. Chalk-line.
16. Set-wedge.
17. Iron Bending Pin.
18. Chipping-knife.
19. Small Shears or Snips.
20 and 21. Rough and Smooth Rasps.
22 and 23. Rough and Smooth Files.
24. Tompion or Pipe Widener—boxwood.
25 and 26. Flat and Round Dressers.
27. Wood Mallet.
28. Shave-hook.
29. Soldering-iron.
30. Solder-pot.
31. Pothook.
32. Spirit-level.
33. Saw.
34. Callipers.
35. Smudge-pot and Brush.
36 and 37. Stone Chisel and Batting-iron.
38. Plane.
39. Compasses.
40. Square.
41. Bossing-pin.
42. Looking-glass.
43. Turn-key.

On next page a sketch, Fig. 4, is given of the interior of a plumber's shop showing the furnace, large pot for *melting lead and* large ladle. Also the plumber's shop fire *with its iron blower* raised up. This iron blower, as will

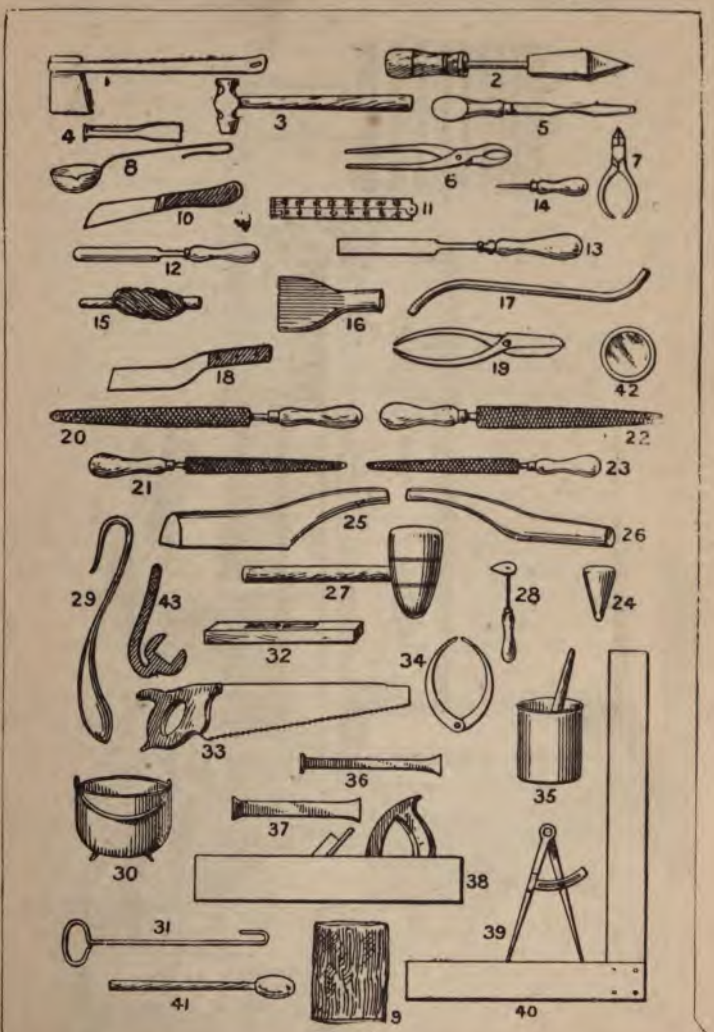

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Fig. 3.

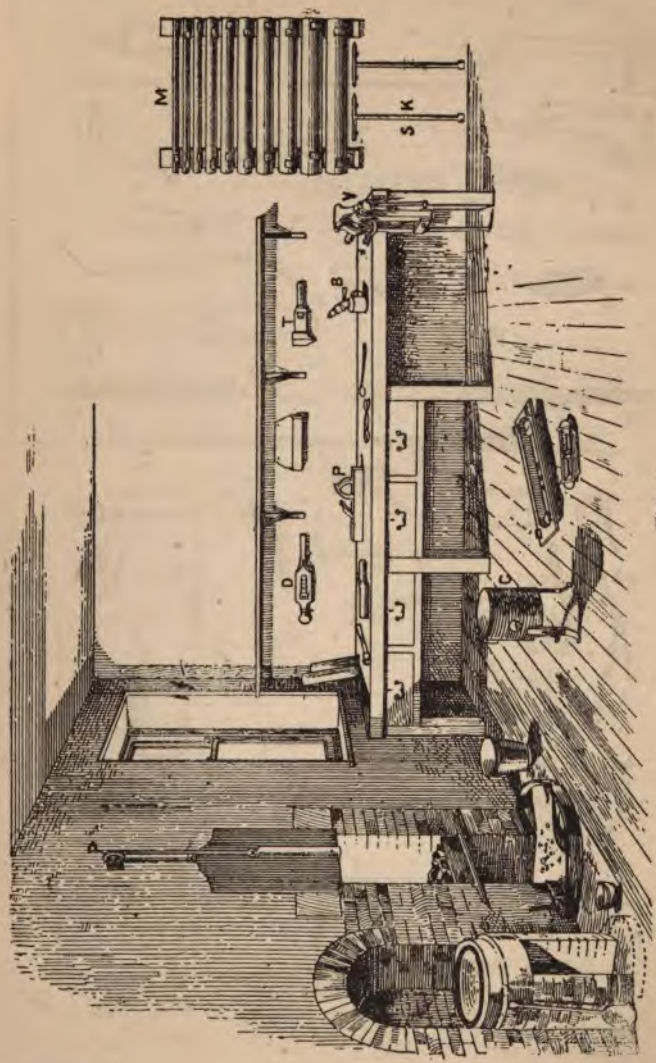



Fig. 4.

be seen, is balanced by an iron weight, the two being held up by the chain or cord hung over the pulley P.

At the side of the fire is seen a pail, generally kept nearly full of water for cooling the handle of the soldering irons. In the middle of the floor stands a plumber's chaffer, and beside it on the floor are lead and solder ingot moulds. A vice is seen attached to one end of the bench, while on it lie several tools, including a gasoline blower B, for soldering with independent of a fire, a copper hatchet bit, shears, plane, dresser, and screw-wrench. On the wall are seen dies for screwing brass pipes, and purchase tongs, and also set of wood mandrels from 1½ in. diameter to 6 in. diameter, also two iron stop-cock keys.

Fig. 5 shows a plumber's lead-burning machine used for joining two pieces of lead together with lead in place of solder. This machine consists of two principal parts, viz., the atmospheric air-pump and the hydrogen gas generator. The former is a cylinder fully 4 ft. high and 1 ft. diameter. It is made say of No. 18 galvanized sheet iron, with a water-tight division across its centre. From the bottom of this division a pipe 1½ in. or so in diameter is suspended as indicated at K, while another and smaller pipe J about ⅜ in. in diameter is led up as shown, to act as an air-pipe from the hand force-pump P. When the pump P is to be worked the top division of the cylinder W is nearly filled with water. This water runs down into the lower space Y through the pipe at K. When the pump P is worked the atmospheric air is blown into the division Y and so presses up the water into the upper receptacle W. This water in W then tends to regulate the pressure of the air delivering through the air-pipe J and india-rubber pipe L to the forked junction pipe A B. H is a stop-cock for regulating and stopping the air passing up through the pipe J.

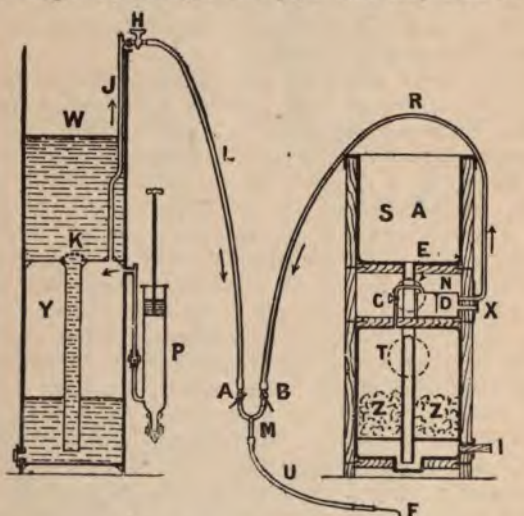
The hydrogen gas generator stands about 3 ft. 6 in. high* and is in three divisions or compartments. It is made of wood and has the upper and lower compartments lined with sheet lead. The seams and pipe junctions are burned, not soldered.

In the lower compartment is placed the zinc or spelter Z Z, which is shown resting upon a perforated shelf or false

* The S A compartment of one beside me now is 12½ in. long × 8 in. *wide inside.*

bottom made of heavy sheet lead. The zinc is put in through the 4-in. trap-screw opening T. I is a wooden plug.

After the zinc is put into the lower chamber and the trap-door T closed, water and sulphuric acid, in the proportion of fully two-thirds of the former to one-third of the latter,* are put into the upper chamber, from whence they flow by the 1 in. or 1¼ in. pipe E into the lower chamber, when hydrogen gas is generated which gets into the small lead box or safety chamber N, in the middle, with its divisional tongue D, through the pipe and stop-cock C. The




Atmospheric Air Pump. Hydrogen Gas Generator.

Fig. 5.

hydrogen gas then passes on through the ⅜-in. india-rubber pipe R to one side of the fork B, when the gas passing through the stop-cock B meets with the air passing through the stop-cock A at the pipe M, to which is attached the india-rubber tube U and nozzle F.

* Mr. Hellyer says his proportion is 7 lbs. of zinc clippings to 3 quarts of water and a pint and a half of sulphuric acid. When working a pint of acid is added about every two hours, the zinc lasting *eight or ten days. In heavy* work much more zinc will be used in less *time.*

For light work a small nozzle is used, for heavy lead, a larger sized one.

When too much liquid has condensed in the safety-box N it can be let off by unstopping the short pipe X. When doing so the cock C should be shut and any light or flame held away from X in case of explosion. The stopper at X may be a half coupling with the hole in the ring filled up.

When putting the water and sulphuric acid into S A compartment, open the cock C to let air out from the Z Z compartment, so that the liquid may get down. Then shut cock C. When the gas has been generated it forces the liquid back up into the S A chamber. When using the air-hydrogen blow-pipe for joining lead, the edges of the lead should be shaved bright and the thin narrow strip of lead used in place of solder should also be shaved clean and bright. The jet tube is held in the right hand, the lead strip in the left. For practice the india-rubber tubes L and R are much longer than in Fig. 5 to allow for moving about.

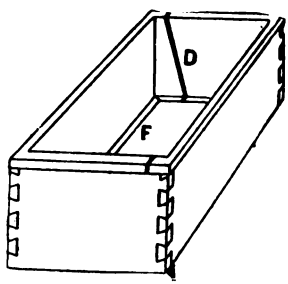


Fig. 6.

After using the machine the saturated liquid should be drawn off, by taking out the plug at I, to prevent deposit.

When lining a cistern or suchlike the seams are not kept in the corners as with soldering, but the lead for the

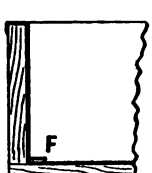


Fig. 6A.

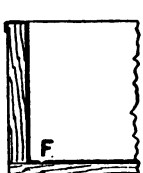


Fig. 6B.

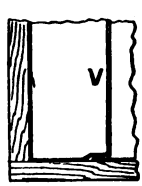


Fig. 6C.

sides is bent an inch and a half or so on the bottom as per F, Figs. 6, 6A, and 6B, so that the lead-burning may be done on the flat. Then at the upright ends of the cistern the seams are sometimes burned diagonally as per D, Fig. 6,

beginning about 9 or 12 ins. out from the corner at the bottom and finishing about 2 ins. out at the top as indicated in the sketch. The slope D is to allow a rest for the lead used in the burning. A good workman, however, can burn the seam quite vertically, as at V, Fig. 6C, the seam being kept a foot or so back from the corner to give the man room to work.

In Figs. 6, 6A, and 6C, the lead is shown overlapped. In many schedules this overlap is stated to be an inch and a half. In Fig. 6B, the lead is shown edge to edge at the seam F.

In patching some men simply lay the lead patch against the other lead forming the vertical walls of the chamber, and burn all round the laid-on patch. In other cases a less skilled burner will make a slit horizontally in the main sheet lead for his patch to slip through an inch or so, and so he gets a rest for his seam along the bottom of the vertical patch.

The saturated acid should not be left lying in the bottom compartment Z Z, but should be drawn off through the pipe I after each service of the machine in order to prevent deposit inside of sulphate of zinc.

## CHAPTER III.

### HALF-CIRCLE EAVES GUTTERS.

"THE roof is ready," is generally the signal which brings the plumber upon the scene. The mason begins at the foundation or the bottom, the plumber, however, begins at the top. The mason—or bricklayer, &c., as the case may be—has carried up the walls to their destined height, the joiner has done his share, so far, by laying the joists and doing the woodwork of the roof, and now the plumber has to do his part at making things watertight, and conveying away the rain-water which may fall upon the roof.

There are many ways of doing this, just as it happens to be a large or a small roof, a simple or a complex one; a cheap job, where nothing but plain half-circle eaves gutters are allowed, or one where tons of lead are required for the gutters, flashings or skews, valleys or flanks, skylight openings or dormer windows, hips or piends, ridges, and perhaps one or more flats, or "platforms," as they are sometimes styled.

If it be a plain roof with two gables, we will say that only simple half-circle iron rhones—*i.e.*, half-round eaves gutters made of cast iron—are to be put along the eaves on the back and front of the house. In such a case gutters 4½ in. wide—which is a common size—may do; although they can be had from 3 in. upwards. These 4½ in. cast-iron gutters, of which Fig. 7 shows transverse section, are generally cast in 6-ft. lengths, with a faucit at one end; but, of course, short pieces can be had to any length, or as much can be cut, filed, or chipped off a full length as to reduce it to the size desired, and a new hole for the bolt, Fig. 8, has then to be

Fig. 7.

drilled. Angular gutters can also be had of different shapes, to fit or turn round all sorts of corners.

Fig. 8.

If one half-circle gutter is merely to go along the front of the house, and another along the back, then, according to the length of frontage, &c., so will be the number of the lengths of gutter required, *e.g.*, if the frontage be fully 35 ft. then six lengths will do; with a "close-end" on each end of the gutter and a nozzle, pap, or drop, as it is variously termed, to conduct the rain into the rain-water pipe (or "conductor"), as per Fig. 9.

Fig. 9.

The close ends may be had either loose or cast on, but the nozzle is cast along with the gutter. Short pieces of gutter with the nozzle, called "nozzle-pieces," may also be had. In cases where the conductor has an ornamental rain-water-head at its top, then the nozzle and one close end are often dispensed with, and the gutter allowed to run quite openly into the rain-water-head, as per Fig. 10. Many prefer the nozzle, however, as it prevents the water running back on the under side of the gutter. This may be prevented by putting on a small piece of sheet lead under the end of the gutter. This iron gutter is supported by malleable iron hooks about $1\frac{1}{4}$ in. or $1\frac{1}{2}$ in. broad, and from $\frac{1}{8}$ in. to $\frac{1}{4}$ in. thick. These hooks are made to fit the outside of the gutter, so that the gutter may lie properly in them, and while at the higher end of the gutter the hook is shallow, at the other end, owing to the declivity which the gutter requires for the proper flow of the water, the hook has to be so much deeper.

Fig. 10.

Fig. 11 is a view of the shallow hook, and Fig. 12 the deep hook, with the two slate nails or $1\frac{1}{2}$-in. screws which fix it to the wooden roof. In some cases the hooks have *to be let into the stone*, when they are either wedged in

firmly, or else, a hole being cut in the stone, the inner end of the hook is bent down, and being inserted into the hole, the hole is run full of lead, as per Fig. 13. This has to be done just as the exigencies of the case may require and the circumstances allow.

Fig. 11.

Fig. 12.

To make the hooks for a 4½-in. iron gutter about (say) 48 ft. long (which gives eight 6-ft. lengths, minus about 1½ in. off for the slip, or overlap at each joint, if the lengths are cast exactly 6 ft. long), will require about 27 ft. of hoop iron, as, allowing for two hooks for each length, or one hook every 3 ft., there will be seventeen hooks, and each piece of iron of a different length. The shortest piece will be 18 in. long, which allows 11 in. to go up the roof, and 7 in. to support the gutter; every other piece is cut a little longer, say, one-eighth of an inch, which in this case, where the gutter is supposed to have a run all to one end, gives about two inches of declivity in all, or a quarter of an inch to each length.

Fig. 13.

When the pieces of hoop iron which are to form the hooks are cut, they are arranged as per Fig. 14, and a mark struck across them from A to C, A being 7 in. from the end B, and 11 in. from the end E, while C is 9 in. from the end D, and 11 in. from the end F. This arrangement gives 7 + 11 = 18 in. as the length of the shortest hook, and 9 + 11 = 20 in. as the length of the longest hook; the length of the others being all intermediate between these. The pieces at the ends B D may then be heated and bent square as per Fig. 15 at the marks A—C, and being again heated to redness at the same end the points B D are, one by one, inserted into the nose or catch of an iron mould specially made for that purpose, and the hook formed by the hoop iron being bent over it as per sketch Fig. 16.

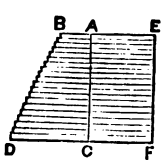



Fig. 14.

Two or three holes having been punched for the nails as shown in *Fig. 11, the hooks*, when brought to a mild heat,

are tarred, and after cooling are ready for use. In place of tarring the hook, when time allows, it may be painted, first with a coat of red lead, and then a coat of paint of the same colour as the gutters. When galvanized hoop-iron is used, heating and tarring and also painting are generally dispensed with. This non-protection is not to be recommended, however.

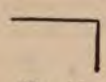


Fig. 15.

Each of the above lengths of gutter has a faucit end and a spigot, or plain end, the plain end of the one length fitting into and lying upon the faucit of the next length. The joint is made tight with putty or red lead, the spigot of the one length and the faucit of the other being squeezed together and kept tight by means of the bolt and nut, as per Fig. 17.

Fig. 16.

After these iron gutters have been put up it sometimes happens that they are blown down in a gale of wind; to prevent that, however, the gutters should either be tied to the hooks with copper wire, or else pieces of hoop iron are fixed to the roof at one end, and the other end put across the top of the gutter to protect it and keep it down, as per Fig. 18. For zinc gutters the hooks have to be made in the same style as above, but the lengths of zinc gutter, in place

Fig. 17.

Fig. 18.

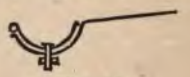


Fig. 19.

of being screwed together, with putty, &c., are soldered, while to keep the zinc gutter in its place an iron bolt can be passed through the bottom of the gutter and through a hole made for it in the bottom of the hook, and so it is kept fast, as per Fig. 19. The iron bolts above spoken of are about 1 in. long and ¼ in. thick. The holes in the gutters, &c., are, of course, of a corresponding size.

Sheet lead used to be largely employed for these half-round eaves gutters, but it is now getting out of use in many cases, on account of the large adoption of cast iron. *In some* cases, malleable iron has been applied for the purpose. *It requires to* be well painted.

*Fig. 9 shows a plain* half-circle cast-iron gutter. Fig. 20

is cross section of a half-circle cast-iron gutter, with a small bead or moulding along its front edge. Fig. 21 is cross section of a half-circle eaves gutter made out of sheet lead of from 6 lbs. to 8 lbs. per square foot. The front edge is turned round as shown, about ⅜ in. or ¾ in. in diameter for

Fig. 20.

Fig. 21.

stiffness to the gutter. The hooks to support this lead gutter should be 1½ in. broad, and not more than about 2 ft. apart; close ends, joints, paps, and angles may be all soldered, but circular gutters can be worked.

Instead of the hooks being fixed by nails, as in Figs. 12 and 18, they may be driven into joints or holes in the wall, in which case they are formed as per Figs. 22 and 23.

Fig. 22.

Fig 23.

Figs. 24 and 25 show specimens of the angles for half-circle gutters, the former being a square left-hand angle, and the latter an obtuse right-hand angle.

Fig. 26 is a short union faucit. It could be used, *e.g.*, for joining the two spigot ends S S of Figs. 24 and 25 angles; said

Fig. 24.

Fig. 26.

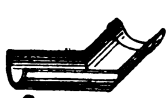



Fig. 25.

Fig. 27.

spigot ends lying inside the union faucit, so that this union faucit is, of course, fully wider inside than the spigot ends of the gutters over all.

When the short union-piece is intended to go inside the two faucit ends of two gutters, it is styled a clip, and is simply a short piece of the gutter with two holes in it for the iron screw bolts. The union faucit has also a hole at each end of it for the bolts.

Fig. 27 shows an iron drop or nozzle-piece, with a faucit at each end, and the "pap," "nozzle," or outlet for the rain, P, in the *middle*. Angles like Figs. 24 and 25 may also be *had with drop in bottom* as required.

## CHAPTER IV.

### Ornamental Iron Gutters.

In the foregoing chapter plain semi-circle gutters (or *rhones*, as they are sometimes called), which may possibly be considered to partake more of the character of an excrescence and a necessary evil than an ornament to the building, were treated of. In this case, however, we come to treat of ornamental iron eaves gutters, which are necessary to the completion of the design, and which, as the old saying has it, "kill two birds with one stone," and at one and the same time they serve either as the whole or a part of the

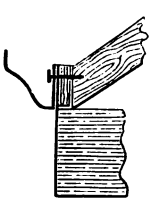


Fig. 28.

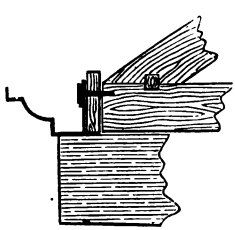


Fig. 29.

Fig. 30.

cornice mouldings, as well as acting as gutters for the rain-water.

These ornamental iron gutters do not, generally speaking, require hooks, as provision is made for them being screwed to the woodwork of the roof, a board about 1 in. or 1¼ in. thick, and about the same depth as the back of the gutter being fixed up along the back of where they go for that *purpose*. In some cases all the weight of the gutter is *borne by the screws*, as per Fig. 28. In other cases a great

part of the bottom of the gutter lies on the wall head, as per Fig. 29. In some cases they are upheld by ornamental iron brackets, as per Fig. 30, which brackets are of various styles to suit the place.

These ornamental iron gutters require to have close ends —unless in cases where they go all round the building, as in some cottages and villas—and nozzles, just as the plain half-circle ones do, only they are not put up with a declivity to the nozzle, for that would spoil their appearance; they are fitted up quite level or horizontal, but owing to their being several times deeper than the half-circle

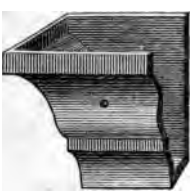


Fig. 31.

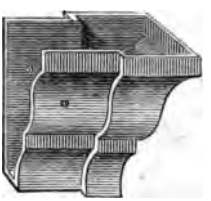


Fig. 32.

gutters they can dispense with a declivity. The depth of a 4½-in. semi-circle gutter is only about (or scarcely) 2 in., whereas the depth of ornamental gutters may be 3 in., 6 in., 8 in., &c., with a corresponding breadth, according to circumstances, and as the size of the roof or the character of the building may require.

In order to keep an unbroken line of frontage, ornamental iron gutters have no faucits, the plain end of one

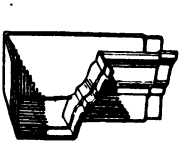


Fig. 33.

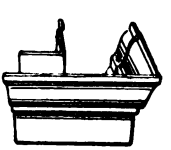


Fig. 34.

gutter acting as the faucit, as in Fig. 31, while the end of the other length is contracted so as to slip into it, as per Fig. 32. These figures, 31 and 32, are not full lengths of gutter, but *terminal ends*; they serve, however, to show the *mode of junction*. The gutters are put together with putty

or red lead, and iron bolts (as per Fig. 8), only the head of the bolt is kept outside, and the hole countersunk so as to leave as little as possible outside to catch, or to be offensive to, the eye. The iron-bolts in this case are also a

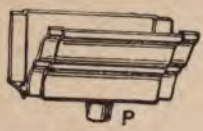



Fig. 35.

Fig. 37.

Fig. 36.

little thicker, as well as longer, than for the plain semi-circular eaves gutters.

Fig. 33 shows an inside angle for an iron ornamental gutter, and Fig. 34 an outside angle. Fig. 35 shows a

Fig. 38.

union piece with an outlet pap or nozzle P in its bottom, fixed on vertically. Fig. 36 shows the nozzle fixed on at an angle at the bottom back corner of the gutter. Fig. 37 is a short union or junction piece.

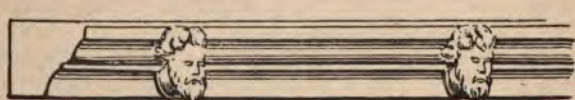


Fig. 39.

Fig. 38 shows a different style of iron gutter, the gutter in this case being ornamented in front with panthers' heads fixed on. Fig. 39 shows men's heads affixed. Fig. 40 is a plain square, or boundary wall, iron gutter.

Fig. 40.

There are so many patterns of these ornamental iron gutters, some with very elaborate mouldings, that we can only refer to them here, this not *being a pattern book*. What has been said will serve to *show the principle* upon which they are fitted up.

Before concluding this chapter, allusion may be here made to iron centre gutters, which, as they are not put up for ornament, but simply for use, can be made with any declivity wanted, in which case the sole or bottom of the gutter is cast tapered, perhaps 6 in. broad where the water runs off, and 10 in. or 12 in. broad at the higher end.

In other cases they are cast without any declivity, being laid level, and therefore the same breadth throughout. The two sides, however, in all cases require to be made to suit the pitch or inclination of the roof, or else the inclination of the roof is set so as to fit them, if they are selected beforehand; generally, however, the gutter is made to fit the roof as at R, Fig. 41, where the nozzle, S, is also shown for the outlet, by which the water may be conveyed away by the rain-water pipes as circumstances may require.

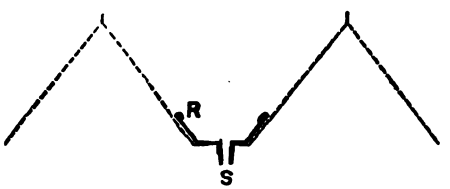



Fig. 41.

These iron centre gutters are made with enlarged faucits, the same as semi-circle gutters, not with contracted ends the same as the ornamental iron gutters above alluded to. They are joined with putty and red lead, and bolts and nuts, the bolts being $1\frac{1}{2}$ in. long and about $\frac{3}{8}$ in. thick. Three bolts are used for each joint, but in some very broad gutters four bolts may be used. Each length may be had either 6 ft. or 7 ft. long, according to the usage of the foundry they are got from; shorter lengths may be had to order or to make up the exact length required.

## CHAPTER V.

### Lead Gutters.

We come now to treat of roofs where the material used by the plumber is lead, and shall take what may be called a plain roof first, or one with two gables, in which are the chimneys, and where the line of both the back and front gutters is uninterrupted in its whole length, of which Fig. 42 gives section, showing front and back gutters. In this case M is the stone cornice on the top of the front wall,

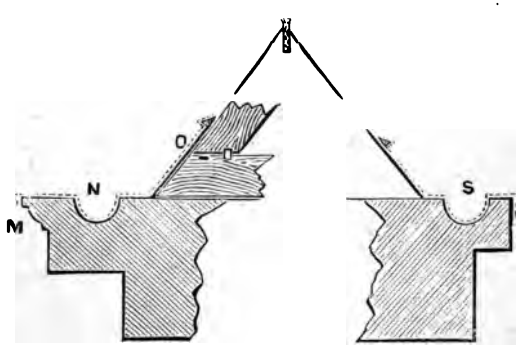



Fig. 42.

in which the valley for the gutter, N, is cut out, say, to a depth of one inch at its upper end, and getting gradually deeper towards the end or place where the water runs off, so that at the deeper end its depth may be about 3 in., while throughout it may have a uniform breadth of, say, *5 in.* The roof comes down as shown at O, and it becomes *necessary, therefore, to* lay the lead so as both to convey

away the rain-water and to do its part in keeping things water-tight at the junction of the roof with the wall-head.

For this purpose the lead has to go across the cornice and up about 6 in. on to the roof, as shown by the dotted line. The breadth of the lead in this case will, therefore, be about 2 ft., which is made up by 1 in. bent down over the front, 5 in. from front to edge of the gutter valley, 8 in. for the gutter valley, and the other 10 in. is taken up by the 4 in. from the back edge of the gutter valley to the roof and 6 in. up the roof, as per Fig. 43. A gutter about 48 ft. long may be put on in either two or three pieces. If we say three pieces, that, if all are cut to the same length, gives about 16 ft. for each, and if the weight of the lead be 7 lb. per square foot, each piece will weigh about 2 cwt.

The lead being carried up to the roof is then rolled out there, near, or just above where it is to go, each piece by itself, and after being "dressed," or beaten out flat, it is then marked off where to be bent up in a manner suitable

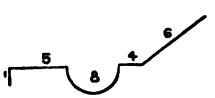



Fig. 43.

Fig. 44.

to its intended site. For the gutter we are speaking of the mark—at the deeper end—is set at 10 in. from the front at one end and 9 in. from the front at the other end, after which the lead along its whole length is bent up according to mark (as per Fig. 44). It is then lifted down and set inside the gutter valley in stone, and being bent back and over it is then properly "dressed" into its place, and afterwards cut or pared evenly along the edges. When measuring off the length of lead, allowance must be made for any upstand or turn-over at the ends of the gutter, according as the site may require. After the gutter has been laid the "doubling," or long narrow wooden fillet for slates, has then to be put on all along the upper edge, except about 6 in. at each end where the gable "flashings" come down—*i.e.*, if the said "flashings" go underneath slates. This "doubling," so distinguished because the lead is doubled back *over it, is of* any length, its section being a right-

angled triangle, with the base or breadth about two inches, and the perpendicular or depth about three-quarters of an inch.

Where the ends of the lead gutter pieces meet they must be soldered, it being understood that the stone is cut out a little underneath the joint, so that the solder may be "flush" or level, especially in the gutter valley. Where the joint is soldered thus it both looks neater and forms no obstacle to the water running off freely.

We may here describe the operation of joining two lead gutter pieces *in situ*. After the lead is put into its proper place, as described above, its surface for about 4 in. on each side of the joining is rubbed with a piece of card and chalk to take off the grease, &c.; it is then on the same space painted over with "smudge" (a mixture of lamp-black, glue, or size, and sour beer or water, boiled together), and after said "smudge" has been dried, say with a hot iron, about 1 in. back from each edge of the lead is then cleanly scraped with the "shavehook," and to prevent its being tarnished or oxidised it is immediately rubbed over with fresh grease, often a piece of tallow candle.

The solder-pot and soldering-irons in the interim being properly heated, the plumber, by means of his small iron ladle, pours a sufficient quantity of solder on to the joint (not merely as much as makes the joint, but sufficient to raise a heat, all surplus being returned to the pot), and then, by the help of the red-hot irons and his soldering cloth, he wipes his joint.* The soldering-cloths, which are a *sine qua non* with all plumbers, are merely pieces of moleskin or strong linen, of four, eight, or twelve thicknesses, and various sizes to suit the particular work. Old moleskin trousers, and old aprons considered to have served their day upon the plumber's person, are afterwards torn up and made to do duty as "soldering-cloths." These cloths are kept well greased on the side which comes in contact with the solder, so as to prevent the solder adhering to them.

The following rough sketch, Fig. 45, shows a plumber's chaffer-pan, P, as used on roofs, &c. It stands in the centre of a large iron tray, Q (about 2 ft. square and 4 in. deep), in which is water, so that any hot cinders falling out may

* In dry weather this is easily done; but should it come on wet it *is very* disagreeable, both taking more time and solder, and not making *such a neat job*.

be at once quenched. The soldering-iron, R, is all of malleable iron, and is what is used along with the solder heated in the pot.

A distinction must be made between this soldering "iron" and the soldering "bolt,"* the latter being made with a copper head and iron handle. A plumber's copper "bolt" is made something like a hatchet, on account of which shape it is often designated the "hatchet-bolt;" this appellation also serves to distinguish between it and the "pointed" or "straight bolt," the latter shape of copper bolt being that generally used in gas-fitting. As observed above, it is hot or melted solder that is used along with the "iron," whereas the solder used along with the "bolt" is cold and generally in the form of strips, or, as for gas-fitting, in small, thin cakes.

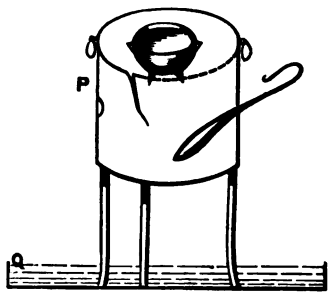


Fig. 45.

Good "working solder"—used with the ladle and the soldering-cloth—is made up by melting pure lead and block tin together in the proportion of 2 lb. of lead to 1 lb. of tin. "Strap solder"—used with the copper hatchet-bolt—is made in the proportion of 1 lb. of tin to fully 1½ lb. of lead. Some just made I find is in the proportion of 1 lb. of tin to 1 lb. 9½ oz. of lead. Some gas-fitting solder just made is in the proportion of 1 lb. of tin to 1 lb. 2 oz. of lead. Some use equal parts of tin and lead for their finest solder.

In making up solder, especially "working solder," or "plumber's solder," great care must be taken that no zinc gets near, for a very small piece of zinc spoils a large pot full of solder. For this reason sheet lead is generally preferred before the patent lead pipes. Formerly sheet lead was cast; now, however, it is generally rolled or milled. For special cases, however, good cast lead is still preferred.

To return to our gutter. We have got the front gutter

* The copper "bolt," by some, is styled a copper "bit." See *Figs. 1 and 2, page 9.*

laid, and a similar course has now to be adopted with the back gutter, S, Fig. 42, only, as there is here less breadth of stone to be covered, the lead may be narrower, say 18 in. in breadth. The length of the back gutter is also sometimes less than that of the front, owing to the stone gable-coping coming down to the outside edge of the back gutter, and so forming the ends of the gutter up against which the lead at each end has to be turned, whereas in the front this stone "skew," or gable-coping, stops off perpendicular with the line of the wall, the cornice, including the gutter channel, being beyond it.

After laying the gutters, the lead "flashings," which extend up the roof from each end of both the back and the front gutters, have then to be put on (that is, supposing them to be put on, as is often done, before and underneath the slates). In this case twelve pieces of lead are required; four for the flashings for skews which extend from the gutter to the chimneys; four pieces for the "barges," or breaks, or projections at chimneys; and four for the flashings up the sides of the chimneys. These, for the different places, are of different lengths and breadths. The flashings for the "skews," or gable-coping T T, being, say 11 ft. long and 13 in. broad, this 13 in. is taken up by 6 in. on the roof, 4 in. up the side of the skew, and 3 in. on the top of the skew, including half-inch bent down in the groove, or chasing, or "raglet," as it is called in Scotland, cut to receive it.

This "skew" or stone-coping of the gable wall, T, as shown by the sketch, Fig. 46, is generally only half the breadth of the chimney, the latter being about 2 ft. broad, or the same thickness as the gable wall. The lead "barge," or chimney corner-piece, U, goes where the skew and the chimney meet, and is put on so as to overlap the top of the skew-flashing, and at the same time be itself overlapped by the flashing of the chimney, V, which comes down on it. This "barge," U, has also to overlap a small portion of the slating, as may be understood from its position on the sketch.

The dotted lines show the margin of the lead flashings on the roof, as also at the same time the situation of the "doubling"—except the "barge" below the chimney, which, as was observed above, goes on the top of the slates. *The "doubling" being* put on thus, a channel for the water

is formed between it and the chimney and the stone side of the skew. The lead for each barge, on account of its situation, has to be fully 2 ft. broad and about 13 in. deep; its depth is taken up by 8 in. or 9 in. on the roof and 4 in. or 5 in. up the face of the chimney. When the barge is

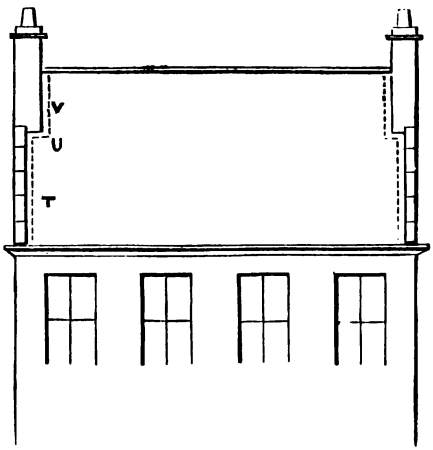



Fig. 46.

being fitted in its place a piece of board about $\frac{5}{8}$ in. thick is put temporarily under it so as to make the barge fit the slates properly.

After the barge is fitted the chimney flashing, V, is then

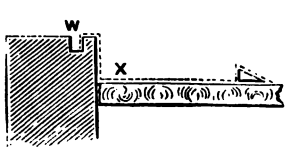



Fig. 47.

put in; its length is, of course, just according to the size of the chimney. We shall say that in this case, including overlaps, it is about 8 ft. long, and its breadth will be about $10\frac{1}{2}$ in., 6 in. on the roof and 4 in. up the chimney side to the chasing, the other $\frac{1}{2}$ in. going into the chasing. *This chasing is a* narrow slit cut in the stone about $\frac{1}{2}$ in.

wide and ¾ in. deep, into which the lead is turned and fixed with lead bats every 6 in. or so; after which the chasing is filled with mastic to keep it watertight.

The diagram, Fig. 47, is a section of the skew, showing the chasing, or raglet at W; the dotted lin X, being the lead.

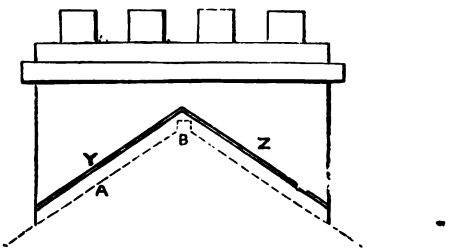



Fig. 48.

All the water in this skew-flashing, X, running down it goes immediately into the gutter.

Y Z again, in Fig. 48, shows how the chasing is cut up the side of the chimney for the chimney flashings, the dotted line A being the line or surface of the roof and B the ridge.*

* The stone chimney here depicted at Fig. 48 is supposed to be built of polished freestone, the blocks at the sides about 3 ft. long, and about 1 ft. high; those at the ends of the chimney 2 ft. long, and some only 1 ft. for filling in. See remarks on page 62.

## CHAPTER VI.

### LEAD GUTTERS (*continued*).

IN Chapter V. the manner of laying the lead in stone cornice gutters, and up the sides of the gables, was explained, both the back and the front gutters being uninterrupted in their whole length. Supposing, however, a building is taken which, in addition to its two gable chimneys, has a chimney, C, in centre of front elevation, as Fig. 49, of

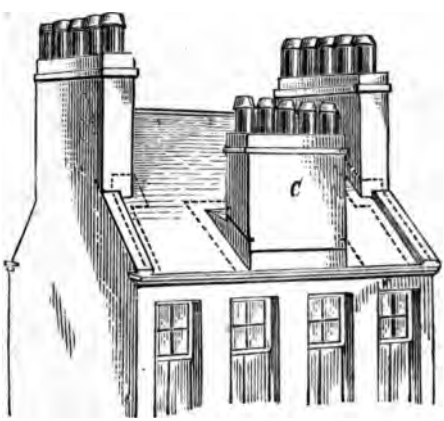



Fig. 49.

which Fig. 50 gives end or sectional view. In this case it will be seen that while the gutter channel is not interfered with, the back of the lead gutter, instead of going up the roof, stands up against the front of the chimney, as shown by the dotted line, D, Fig. 50. It does not, however, go into the *chasing, E, for* that would bind the lead too much;

but the top edge of the lead is kept a little below the chasing, being allowed to stand up about 3 in. or so; and, to prevent the rain getting down the back of the gutter, a long narrow strip of lead, called the "apron," about 4½ in. broad—more or less according to circumstances—is put along the front of the chimney so as to overlap the back of the gutter. This "apron" has its upper edge bent into the chasing, E, where it is held fast by lead bats, and the chasing afterwards filled up with cement or mastic.

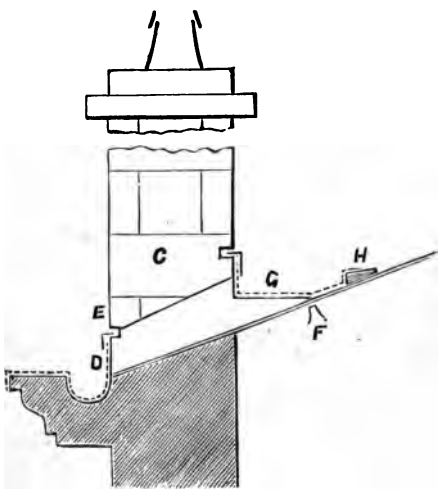


Fig. 50.

It has been said that the back of the gutter fronting the chimney has to be bent straight up, as at D, but as the gutter lead on each side of the chimney lies back on the roof, it follows that the gutter at each front corner of the chimney has to be made to fit the said corners; this is done either by "working" or beating the lead down so that it both lies on the roof and also goes up the side of the chimney so far.

When the lead is to be wrought back into its site, the plumber should take off the sharp edge of the stone corner first, so as both to help himself and prevent tearing the lead. In other cases, instead of working down the lead, some may slit it down close by each end of the chimney, and bend it back, which of course does not thin it any, but causes the plumber to solder in a small piece of lead to make up the deficiency.

Another plan is to have a separate piece of lead for the gutter along the front of the chimney, which would cause the gutter in Fig. 49 to be of three pieces; after laying which, there would require to be two soldered joinings, one

at each corner of the chimney. In this plan, while the lead for the gutter on each side of the chimney might be cut out at about 2 ft. broad, that in front of the chimney would only be about 1 ft. 5 in. broad. In laying all such gutters as these, the lead, being kept *several inches higher at the back than at the front*, should the gutter get choked up by dirt or half-melted snow, there is plenty of margin for the water running harmlessly over the front without any getting inside.

After the gutter has been laid to fit the chimney, C, a lead "flashing," about 11 in. broad or so, has to be put up each side of the chimney; its length—taking the chimney at 2 ft. thick—will be about 2 ft. 10 in., or more, according to the pitch of the roof. It bends round the chimney a little at the bottom, and at the top goes up to the back of the chimney gutter at F, Fig. 50, whatever portion of the lead flashing projects above the sole, or bottom of the gutter, being cut away. This chimney flashing is put into a chasing, as described for chimney flashings in Chapter V. After the flashings are on, a lead gutter has to be laid along the back of the chimney, as per dotted line, G, Fig. 50.

The lead for gutters so situated may be of various breadths, according to the pitch of the roof, and the way in which the carpenter has been directed to lay the wood; a breadth often used is 1 ft. 6 in.—that is, 3 in. perpendicular upstand against the back of the chimney, and the rest across the wooden sole of the gutter and up the roof. And if we take the length of the chimney at 9 ft.—which is also the length of the gutter at its back—then the length of the lead will require to be about 10 ft. 6 in., as it has to extend out at each end as far as the outer edge of the chimney flashings. It has also to be bent or wrought down over and round the chimney flashings at each end, so as to overlap them.

The top of the chimney gutter lying on the roof, as also its ends and the chimney flashings, require "doubling" (or wooden fillet) to be put in under the lead, as per H, Fig. 50, and I, Fig. 51, which latter shows the lead of the chimney flashing as per dotted line. In some cases the plumber may make a small roll on the lead in place of putting in the wooden fillet or "doubling," underneath it; but the wooden fillet, as at I, Fig. 51, is better, and it prevents *the slater from* beating down the lead to fit his slate,

instead of making the slate to fit the lead. The back perpendicular upstand of the chimney gutter is protected by an "apron," put on in the same manner as already described for the front of the chimney.

We come now to a different form of gutter, where, instead of the gutter channel being cut out of the top of the cornice, as shown at Fig. 42, Chapter V., there is a stone "blocking-course" built up above the cornice, behind which is the gutter, of which Fig. 52 gives section—the dotted line J being the lead gutter, and K the stone "blocking-course." In this case the gutter is of a different shape from that at Fig. 42, although the lead required may be of the same breadth—viz., 2 ft. When the lead for it is rolled out on the roof it is marked off and set up to the shape of the gutter, as shown by dotted line J, Fig. 52; the 2 ft. in breadth being taken up by, say 4 in. perpendicular upstand all along the one side, 13 in. at the high end, and 10 in. at the low end, or according to its fall, for the sole or bottom of the gutter; and 7 in. at the high end, and 10 in. at the low end, to go up the roof.

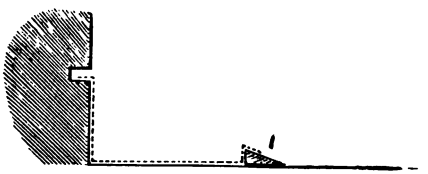


Fig. 51.

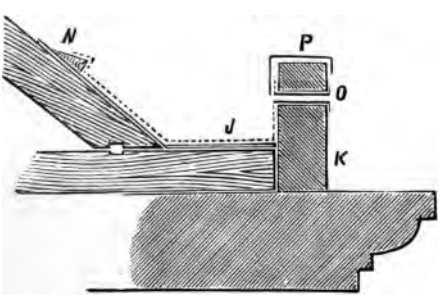



Fig. 52.

After the lead has been thus "set up," before being put into its site, it has also to be set up at each end, so as to form the upstands for the ends of the gutter, which is done, according to the style of the locality, either by working up, or "bossing," as some term it, each end, so that the lead *may* fit its site; or else by bending up the ends and turning *round the corners*, which latter system in some places *receives the cant* terms "pig-lugging" or "dog-earing"

the corners, which may be explained as follows:—Take a piece of white paper, 6 in. by 4 in., as per Fig. 53, and draw a line within it and all round it half-an-inch from its outer edge, as per dotted line, Fig. 53. Bend up the paper at the dotted line, square all round. In attempting to do so it will be found that the corners require to be bent out across or along the diagonals, when they take the form shown at L L, Fig. 54. Press the corners close together, and then turn them round, as shown at M M, and a copy is produced of what is often done with the ends of lead gutters.

After the gutter has been put into its site, the "doubling" (or wooden fillet) has to be put on, under the top of the lead on the roof, as at N, Fig. 52; while for the front of the gutter at the "blocking-course" two things have to be done—viz., an "apron" has to be put on, and an overflow-

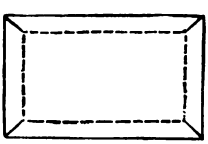


Fig. 53.

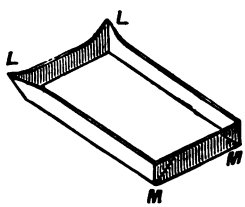



Fig. 54.

pipe has to be put in; so that if the gutter were choking-up, the water would run off harmlessly by this overflow-pipe O, Fig. 52, instead of getting over the top edge of the lead gutter, and so damaging the property.

The "blocking-course," we shall say, is 6 in. across the top; the "apron," therefore, having to cover it, and go down each side, overlapping gutter inside as per P, Fig. 52, will be about 10 in. broad, which gives 1 in. over front, 6 in. across top, and 3 in. down inside. Of course there may be many "blocking-courses" broader and deeper than this, which will require the lead to be broader; but what is said above shows the principle or method of putting on the lead.

The "aprons" on the top of the "blocking-courses" are held fast by lead buttons or rivets, as shown by Fig. 55, which are *made as follows*:—Before the lead apron is put *on, holes are cut in* the top of the stone blocking-course

about or fully 1½ in. deep, and about ¾ in. wide, every 2 or 3 ft.; after the lead apron is put on, a small round hole, about ⅜ in. in diameter, is cut in the lead right over the centre of the hole in the stone; this hole in the lead is made wider by beating the lead out and up at the same time, as shown in Fig. 55; a small portable ferrule, the size of the lead button, being then put over the hole. After the lead has been poured in, got cooled, and been beaten a little on the top with a hammer, the button permanently assumes the shape shown at A, Fig. 55, which gives perpendicular sectional view.

Fig. 55.

In some cases, when the gutters are very shallow—*i.e.*, when they are laid within a few inches of the top of the blocking-course—there is no apron used, the lead being put on all in one piece over the blocking-course, across the gutter channel and up the roof, as per Fig. 56. Whenever gutters are laid in this manner—which is sometimes done for cheapness—and no overflow-pipe put in, care must be taken that the lead is put up the roof a sufficient distance, so that the water, if the gutter gets choked up and overflows, may run over the front of the blocking-course, and not over the top of the lead next the roof. In other cases, where the gutter channel behind the blocking-course is a sufficient distance below its top, the apron, instead of being put on across the top of the blocking-course, as per P, Fig. 52, may be put on inside the blocking-course, a raglet being cut for it, as per Q, Fig. 57. And as, in this case, there may also be sufficient depth for drips, the carpenter can lay his wood accordingly. Fig. 58 shows longitudinal section of lead where such drips, S S, are put in, the water being taken away from the centre of the gutter, as at T. An overflow-pipe, R, Fig. 57, ought also to be put in.

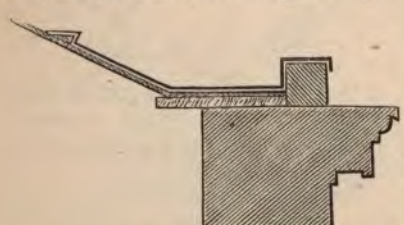


Fig. 56.

In some cases, instead of there being only one pipe, as at Fig. 58, there may be two pipes—viz., one at each end, as per Fig. 59. The drips, S S, S S, should be about 3 in. deep, no *less*, if possible, whatever more. It sometimes happens, especially when the drips are considerably shallower, or less than 3 in., that after the lead has been on some time a quantity of dirt, soot, sand, lime, &c., gets blown up between the two thicknesses of the lead, especially at the corners, and in rainy and blowy weather this dirt, getting wet, acts as a sort of conductor or sponge to suck up the water inside, and so over the top edge of the under lead; when this takes place it keeps the wood under-

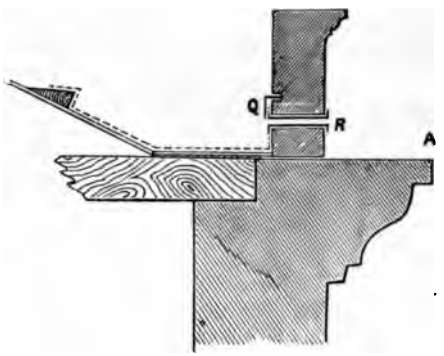



Fig. 57.

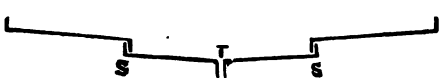



Fig. 58.

neath the lead continually soaking in water, and tends to rot it.

At S S, Fig. 58, the depth of the drips is supposed to be 3 in., the under lead standing up about $2\frac{3}{4}$ in., and the

Fig. 59.

upper lead bent down over it about 2 in. By only bending down the upper lead 2 in., the water or rain falls clear off it, and so *capillary attraction* is prevented and a good *practical job made*. A great many plumbers, however, do

not seem to be aware of this, and instead of doing as shown at S S, Fig 58, they come out in the "fancy" or pseudo-artistic style—shown at B, Fig. 60, where the upper lead is not only bent down the full depth of the drip, but a margin, about 1 in. broad, of lead is also left on the lower gutter. The effect of this is that capillary attraction gets full scope—the water rising up between the two inner surfaces of the lead and wetting the wood.

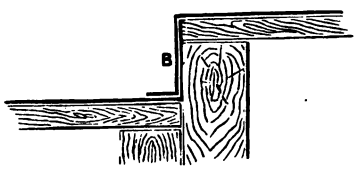


Fig. 60.

The style of over-lapping the lead shown at B, Fig. 60, therefore, although no doubt done with the best intentions, yet makes a very bad job. If any improvement is wanted upon the simple overlap shown at S S, Fig. 58, it may be had by turning down the top edge of the under lead as shown at C, Fig. 61, or a "clinch" may be formed as shown at D, Fig. 62. These two latter styles are adopted where the gutters are broad and much exposed to wind and rain.

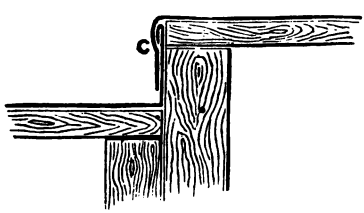


Fig. 61.

When there is a long stretch of gutter, say 80 ft. or 90 ft. long, of the style shown in Figs. 57 and 58, with only one rain-water pipe for it all, then there will require to be about six drips in it; and in order to give each drip a depth of 3 in. the joiner and the plumber should see that the lowest gutter, into which all the others run, is laid as low as possible. In many cases laying the lowest gutter as shown at Fig. 57 will do for a start, the top edge of the first drip being kept up about 1½ in. higher than the bottom of the inner side of the overflow-pipe.

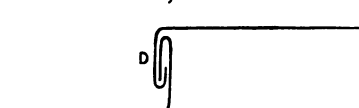


Fig. 62.

*If it is required to* be still lower, as is sometimes the *case, then that may* be done by sinking the sole of the

gutter 2½ in. lower than the top of the cornice at A, Fig. 57; the overflow-pipe, R, being also lowered down until it rests upon the cornice, A, Fig. 57. The joiner in this case must see that the top edge of the first drip is still about or nearly 1½ in. higher than the cornice; while the plumber must see that the water or rain gets exit at the overflow-pipe fully 1 in. lower than the top edge of the lowest portion of the gutter out of which the overflow-pipe is led. The gutters we are speaking of are laid in lengths of from 10 ft. to 12 ft. long, and if the joiner lays down the wooden sole properly an inclination of about 1¼ in. in the 12 ft. is quite sufficient. An inclination of only 1 in., with a 3-in. drip, makes a far better job than an inclination of 3 in. and only a 1-in. drip.

The lead which goes up the sides of the lower gutters at

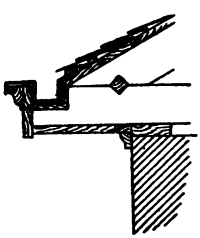


Fig. 63.

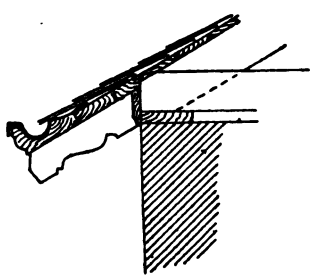


Fig. 64.

the drips should be turned in, or doubled over a little so as to form a small roll (say, ½ in. in diameter), the turn in of the said roll being kept inside the line of the drip. The sides of the lead of the upper gutter at the drips should be left projecting out before the drip about 3 in. or thereby.

We may here mention that the overflow-pipe, R, Fig. 57, is not a round pipe, but a flat or oval pipe made of lead; it is about 6 in. wide horizontally, and 1½ in. high. Its length is, of course, according to the thickness of the blocking-course. When putting it in it must be seen that no rain gets in under it from the outside.

The gutters above referred to are of the style practised, *especially where stone* is the principal material used in con-

struction. In the case of cottages or houses with projecting roofs, Figs. 63 and 64, many little differences in detail occur, and the plumber must make his lead suit the place. To assist in putting the lead into its site in channel in such gutters as here depicted, and also those at Fig. 42, Chapter V., the plumber often gets a piece of wood made the same shape as the gutter channel, only a little narrower, and about 3 ft. long or so, with which he beats the lead into its seat by striking the wood on the top with his hammer, he standing on the wood at the same time, or else pressing it down with his knee.

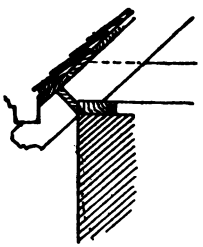


Fig. 65.

In Fig. 65, the gutter shown is an iron one.

## CHAPTER VII.

### FLASHINGS AND VALLEYS.

As regards "flashings," while often put on as per Fig. 51, Chapter VI., they may sometimes, upon a large building, or where a very large quantity of water flows down the flashing, be put on as per Fig. 66, where the lead is about 18 in. or 20 in. broad. The raised piece at T is a wooden fillet nailed on; it is about 1½ in. high, and about 1¼ in. broad, over which the lead is turned, as per dotted line, Fig. 66. Where flashings are put on up against a brick wall or chimney, a different style has to be adopted from that hitherto described,

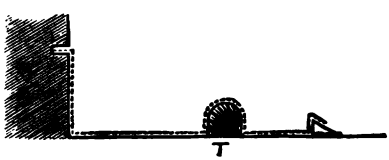



Fig. 66.

as no grooves are cut in the brick the same as in stone. Y Z, in Fig. 48, Chapter V., shows how the raglet is cut up the side of a stone chimney, but instead of the straight line there shown, in brickwork the joints of the bricks serve for the chasing, as per Fig. 67, which shows part of a chimney built in brick.

U V, Fig. 67, is the slope or pitch of the roof, and the undulating lines are the horizontal joints of the bricks. The lowest line and the broken one, which is supposed to be 3 in. above it, show the upstand of the lead or zinc flashing. The line between them, supposed to be 1 in. higher than the lowest line, shows the bottom of the stepped apron pieces, which apron *pieces* overlap the upstand of the lead or zinc

skew about 2 in. or so. The other lines show how the lead steps are put in, the dots showing position of their overlaps. Fig. 68 is cross-section of the skew shown in Fig. 67, w being the lead or zinc stepped apron, and $w^a$ the lead or zinc flashing.

To hold the apron into the joints of the bricks, lead bats

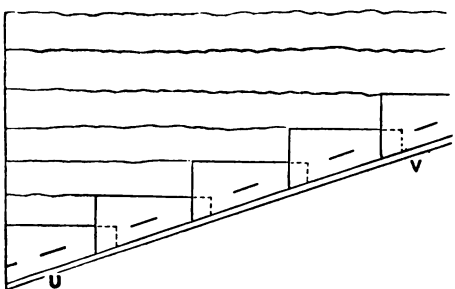



Fig 67

can be used in some good brickwork. In other cases some use wooden wedges, and others, again, use "thumbats," or iron holdfasts, about 3 in. long, and with thin flat heads, as per Fig. 69. After the aprons have been fixed, the joints require to be cemented, or filled up with mastic.

Instead of putting on the flashings as described in Figs. 67 and 68, some use "soakers," or put on the flashing in

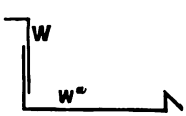



Fig. 68.

Fig. 69.

pieces to suit the bricks and slates, one half of each piece of lead going up against the bricks, and the other half underneath the slates.

In Fig. 67 the horizontal length of each lead step will be about 1 ft. (in other cases it may be either more or less), while the breadth at the lower end will be, say, 7 in., and at the higher end, say, 3 in.; 7 in. + 3 in. = 10 in., gives 5 in. as the medium breadth of each step, which 5 in. being *multiplied by 1 ft.*, the product is the measurement of each

single step. If the sum total is wanted, then, supposing there are ten steps, 5 in. × 1 ft. × 10 = 4 ft. 2 in.

The valleys, or "flanks," as they are sometimes termed, are the inclined channels formed by two roofs meeting, say,

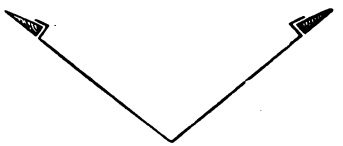


Fig. 70.

at right angles; the breadth of either lead or zinc used is from 1 ft. upwards. "Doubling," or wooden fillet is put on all up each side of these "flanks," especially if lead is used, as per Fig. 70. If zinc be used, however, the wooden fillet is often dispensed with, a small roll being turned in on each side of the zinc for the slates to rest on.

## CHAPTER VIII.

### Ridges and Hips.

The plumber having put up or laid his gutters, flashings, valleys, &c., during the time he has been seeing after his pipes, the slater has not been idle, for he has got the roof all slated, and the plumber may now put on the ridge, indicated in Fig. 46, which may be either of lead, zinc, or iron. The least breadth, generally speaking, of either lead or zinc ridges is one foot, which allows a cover of about 4 in., or fully that, on each side over the slates; but in many cases a greater breadth is used and found necessary, in order to give the slates sufficient cover.

If it is to be lead for the ridge, then a ridge about 48 ft.

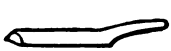


Fig. 71.

Fig. 71a.

long can be put on, say, in three pieces (or as the lead at hand will allow), an overlap of about 3 in. being given where the pieces meet. After the lead has been rolled out and beaten into its place with the usual wooden "dresser," Fig. 71, a strong lead-headed slate-nail is driven in at a distance of, say, every two feet or so into each side of the top part of the ridge. Sheet lead for the ridging may be from, at the lowest, 5 lb. up to 7 lb. or more per square foot. When less than 5 lb., it is often torn up in a high gale of wind, and even although (as is done in some cases where the lead is much exposed to thieves as well as to the wind) galvanised *iron ridge straps* are put on every three feet or so, yet if

the lead be too thin it is sometimes torn up between the straps. These ridge straps are made of hoop iron about 1½ in. broad and ⅛ in. thick, bent into the form shown by Fig. 71a, and with two ¼-in. holes for the nails to go through as shown.

If, however, the ridge is to be covered with zinc, then zinc ridges are generally put on in 8-ft. lengths, with three straps to each length, or one about every 2½ feet. Where the straps are put on at one every 4 ft. it makes a bad job, and does not give the zinc fair play. Each length of ridge is allowed to overlap the other about 2 in. Zinc ridges are made of sheet zinc from Nos. 10 to 14 and upwards. No. 10, which gives about 12½ oz. to the square foot, is indeed little enough; for a good job a greater weight must be used. Anything less than No. 10 should not be put on unless for some mere temporary purpose.

In the neighbourhood of chemical works especially it is a good thing to give the zinc a coat of white-lead paint for protection from the acid fumes. Where this has not been done I have seen the zinc on the side of the roof next the chemical work all eaten into holes and wasted, while the

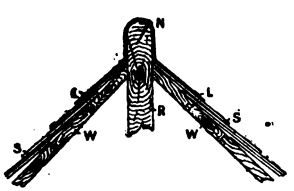



Fig. 72.

L, Lead; N, Nail; R, Ridge; S, Slates; W, Sarking.

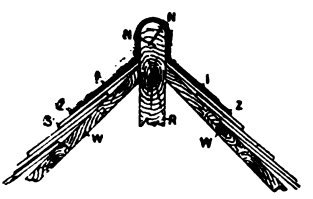



Fig. 73.

I, Iron Strap; N, Nails; R, Ridge; S, Slates; W, Sarking; Z, Zinc.

zinc on the side of the roof farthest from the chemical work was still pretty good. Painting the zinc on the roof, whether gutters, skews, or platforms, is also useful as a general protective, and especially where the zinc is used for low roofs overlooked by the kitchen windows of a higher building.

Fig. 72 is a sketch showing ridge of the roof covered with sheet lead L, N is lead-headed nail, S is slate, W is the wood boarding.

*Fig. 73 is a zinc-covered* ridge showing the ridge strap I

above the zinc; the zinc Z is shown under the strap; N indicates the nails fixing the strap to the ridge R.

Another plan for fastening on the zinc ridges is to groove out the wood ridge as per Fig. 74, and drive in iron staples in the groove, as shown at X; then, at corresponding distances, galvanised iron, or, perhaps, copper hooks are soldered on inside of the zinc ridges, as per Fig. 74a, which shows longitudinal section; after which the zinc ridge is put on and slid along into its place, the hook going through the staple, and thus holding down the ridge. To hold the edge of the zinc ridge zinc clips are nailed over the wood ridge and their ends bent up, so as to clasp the edges of the zinc after the zinc ridge is put on.

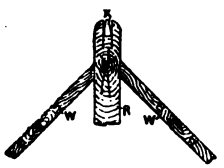



Fig. 74.
R, Ridge; W, Sarking; X, Iron Staple.

This plan, which was known as Fox's Underlock Fastening, is, so far as ridges are concerned, more troublesome and expensive than the former, described at Fig. 73, with straps, but it appears to have the advantage of doing without holes through the zinc ridge, although many may consider that holes in a good zinc ridge which are filled up by either a copper or a lead-headed iron nail, and protected by the galvanised iron strap, are in practice quite harmless.

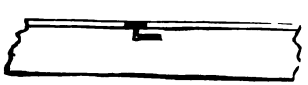


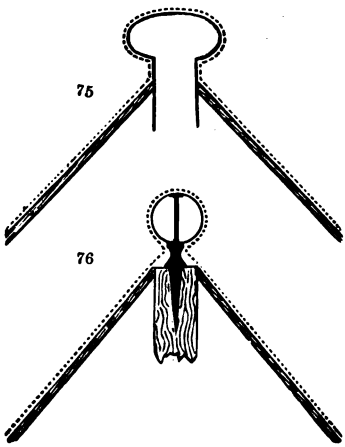
Fig. 74a.

Another plan of putting on lead on ridges is that shown by dotted line, Fig. 75, which requires the lead to be about 18 in. or 22 in. broad. When the top part is kept about, or fully, 4 in. broad, the plumbers or sweeps, &c., may then walk right along on the top of the ridge, in place of on each side of it, and so save the slates.

Fig. 76 is section of another style of ridge; to hold on and keep in position the round wooden baton, shouldered iron spikes are used, which are first driven down into the wooden ridge below them, and, holes being bored in the wooden baton, it is put down on the spikes to the shoulder, and the top of the spike projecting through the hole is then bent over so as to hold like a rivet. The lead or zinc is *then put on as per* dotted line Fig. 76.

*Iron ridges are put on as cast by the ironfounders*; some

foundries cast them in 4-ft. lengths, but they can be made as ordered. They are cast to suit the pitch or inclination of the roof. They can be had either quite plain, as per Fig. 77, or with many different styles of ornament to suit the character of the building, as per Fig. 78. The one length




Figs. 75 and 76.

overlaps the other, and as each length is cast with a raised bead at the one end, and a corresponding raised cover, or overlap at the other end, the bead of the one length is covered by the overlapping socket of the other length, and so the junction of the two lengths is made water-tight.

Fig. 77.

Fig. 78.

Figs. 79, 80, and 81 show other patterns of iron ridging. In place of cast iron, tile ridging is now often used, both plain and ornamental. The tile ridging is laid with lime or cement.

The hips, or *piends* as they are sometimes called, which are the external angles formed by the meeting of two sloping sides *of a roof*, as at Fig. 94, A A, further on, are *generally covered in a similar* manner to the ridges, and are

put on before them. In some cases, however, the lead of the hip is put under the slates, and is therefore put on before the slates. In other cases one half of the lead

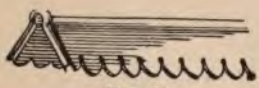


Fig. 79.

Fig. 80.

goes above the slates, while the other half or side is put underneath them. This latter is done when two sides of a roof meet at different angles, and the lead must be put on under the slates on one side in order to make the roof water-tight.

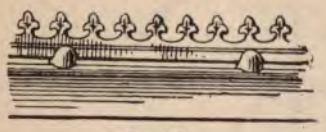


Fig. 81.

When it is intended to put the slates on both sides of the hip above the lead, the hip rafter should be kept somewhat higher than when the lead goes above the slates, as the appearance of the roof is greatly marred if the edge

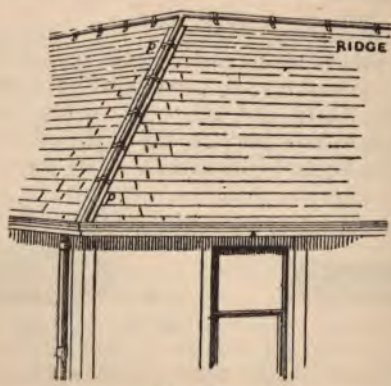



Fig. 82.

of the slates shows as high as the hip. A bold hip also serves as a wind-protector to the slates.

*In Fig. 82,* P P shows the hip or piend stretching down *from the ridge to* the gutter.

## CHAPTER IX.

### LEAD-COVERED FLATS, OR "PLATFORMS."

WE shall now describe the method of using lead and zinc in covering flats, or "platforms," as they are sometimes called, on the roofs of houses, and shall, for illustration, take a flat 16 ft. long and 12 ft. broad, of which Fig. 83 shows section, and which is to be covered with lead. In this case the water runs off at each side of the flat, the rise in the centre being about two or three inches.

Several things have to be attended to here. A flashing about 1 ft. broad, say of sheet-lead, 6 lb. per square foot, has to be put on all around the front of the flat, which flash-

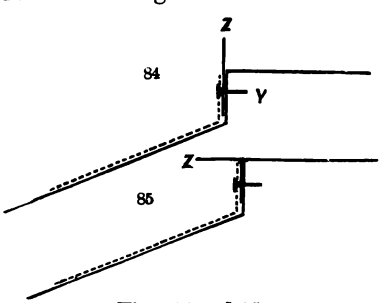
Fig. 83.

ing can be cut in four pieces, two at about 17 ft. long for the front of the sides, and two at about 13 ft. long for the front of the ends. Four long strips of lead about 4 in. broad are also required to go along front of flat for clinch, two at 16 ft. and two at 12 ft. long. Then the lead for top of flat has to be cut out, say, of 7 lb. sheet-lead, the breadth of the several pieces depending, of course, upon the number of rolls it is intended to have in the length of flat.

We shall take the number of rolls at seven, which—as the length of the flat is 16 ft.—makes the distance between the centre of *each to be 2 ft.*, and the number of pieces of lead

eight.* Before cutting out the lead the size of the rolls must be settled, as some allow 3 in. and 4 in. for the roll, and others 2½ in. and 3½ in. I shall, in this case, take the latter, which causes the breadth of each of these eight pieces to be 2 ft. + 2½ in. + 3½ in. = 2 ft. 6 in.; and the length 12 ft. + 4 in. + 2 in. = 12 ft. 6 in. (or, to allow sufficient for the overlap over the front, better say, 12 ft. 7 in.). The extra 6 in. in the latter is for the overlap and turn-in, or "clinch," at each end.

The first thing to be done, in putting on the above lead cut out, is to nail on the long narrow 4-in. lead strips all round the edge of the flat with 1½ in. flat-headed nails, leaving the top of the lead to project up 2 in. as per Z, Fig. 84. Then, in front of this, put on the lead flashing—cut out at 1 ft. broad—as per dotted line, Fig. 84. Its top edge being nearly on a level with the top of the flat, about 3 in. is taken up by the perpendicular upstand, while the other 9 in. lies down on the roof. These flashings overlap each other at the four corners of the flat. Both the flashing and the narrow strip of lead, or "clinch," at its back, are held by nails driven in as at Y, Fig. 84.



Figs. 84 and 85.

After the flashings have been all properly fixed and dressed, the upstanding lead at Z, Fig. 84, is then turned down level with the top of the flat as per Z, Fig. 85, and its outer edge planed straight. The situation of the rolls is then marked off as per Fig. 86, which shows longitudinal section of flat. Then one of the 12 ft. 7 in. + 2 ft. 6 in. pieces of lead is taken, and after being rolled out across the flat and dressed, it is set up (*i.e.*, turned up) all along each side, as per A, Fig. 86, the upstand at one side being 2½ in. and at the

* In cutting out the lead do not scrimp it, more especially as any cuttings are not lost, but melt up again. While I have taken the distance between the rolls at 2 ft., some may make it 2 ft. 6 in., but *the former is best* for lead, and in some cases the distance may be 1 ft. *9 in. or 1 ft. 6 in.*

other side 3½ in. high. Another 12 ft. 7 in. + 2 ft. 6 in. piece of lead is taken, rolled out, and set up in the same manner, and then put close alongside the former piece as per B, Fig. 86, the side with 2½ in. upstand of B being next the 3½ in. upstand of A (the top of 2½ in. upstand of B hav-

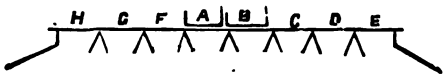



Fig. 86.

ing been planed straight before being placed close to it). The upper part of 3½ in. upstand of A is turned over B as per I, Fig. 87, the seam being beat close. The lead is then beat down all along the seam as per J, Fig. 88, and so the first lead roll is formed.

The same process is repeated with the lead at C, the 3½ in.

Fig. 87.

Fig. 88.

upstand of B turning over on the 2½ in. upstand of C; the same with D and E; then back to F. Where several hands are at the work, one portion may be doing F, G, H, while the other is at C, D, E. The 3½ in. upstand of F folds over the 2½ in. upstand of A, and so on with G and H, only in the case of E and H their outer edges have to lap over the lead

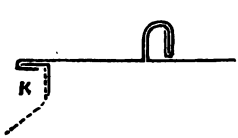



Fig. 89.

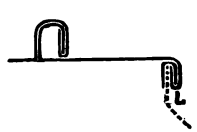


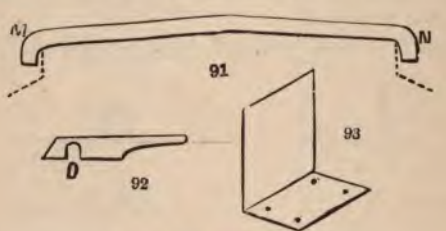

Fig. 90.

shown at Z, Fig. 85, and to be folded in, or "clinched," as per K, Fig. 89, and then bent down as per L, Fig. 90, and beat quite close. What is done to the "outer edges," or sides, of H and E, as per K and L, has also to be done to the ends of H and E, as also to the ends of all the rest, and at

the same time; and, in addition, both ends of the seven rolls have to be bent down about 2 in. over the edge of the flat. In bending or working these rolls down over the edge of the flat, as per M, N, Fig 91, some can do so without stuffing them; others, again, prefer to stuff the ends of the rolls before beginning to turn them.

This stuffing is done by taking a piece of sheet-lead, about 9 in. long, and rolling it up firmly to the thickness of one's little finger or so, and then slipping this into the roll: the roll is turned down with stuffing in it. When being turned down a small portion of the end of the roll which is too long is cut off.

While working these rolls one of the wooden dressers, cut out to the shape and size of the rolls, as per O, Fig. 92, is generally used. In order to tie down these lead rolls along




Figs. 91, 92, and 93.

their length, lead latchets or "clips" are put inside the roll. These latchets are simply pieces of sheet-lead, about 5 in. long, and 3 in. or 4 in. broad, which are fixed on to the top of the flat, as per Fig. 93, with screw-nails; 2 in. on the flat, and 3 in. of upstand; they are put on every 4 ft. or so, the upstand going inside the seam, as between A and B, Fig. 86; and as B on that side only stands up $2\frac{1}{2}$ in., while the latchet is 3 in. high, the top of the latchet is bent down over B, and in order to leave no mark in the seam, the thickness of latchet lead is cut out of B's $2\frac{1}{2}$ in. upstand; and, of course, as the lead is being turned over to form roll, Fig. 88, the latchet is turned with it, and perforce takes the same shape, being inside it. The 2 in. of latchet, which is fixed to the wood of the flat, is sunk down in the wood the depth *of its own thickness*—viz., about one-twelfth of an inch. As *this latchet goes* between A and B, Fig. 86 (and in all the

rolls—say two to each—which gives fourteen latchets), it is, of course, fixed on before A and B, &c., are brought together; 5 lbs. sheet-lead will serve for the latchets.

In this style of covering flats with lead no wooden batons are required at all, while the lead is left quite free to expand and contract. In turning over the rolls they should always be turned towards the side which is least exposed to the wind and rain. In beginning to lay the lead on the top of the flat—although in Fig. 86 I have, for the purpose of illustration, begun in the centre with A and B—the plumber may begin at the side—viz., at E, Fig. 86, and in turning the rolls he must be careful to keep them all straight and even. Fig. 94 is sketch of the flat when finished and covered with lead, as above described.

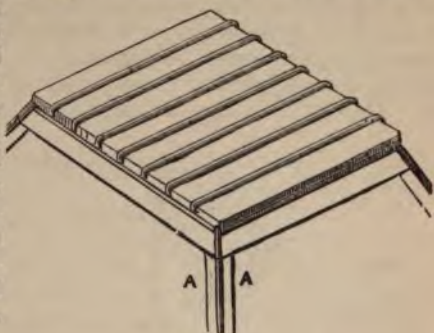



Fig. 94.

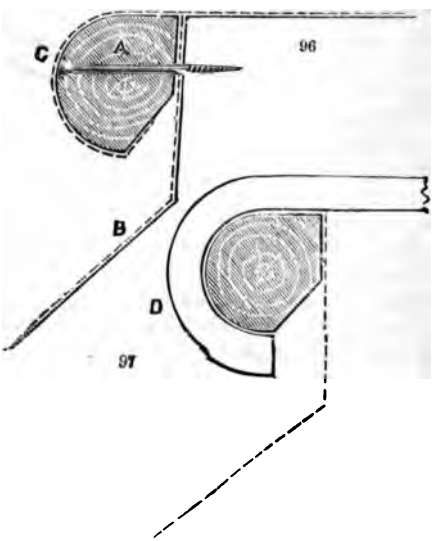
Fig. 95.

In the above style of work no wooden batons are used, but as some may prefer to have them, say where the lead is apt to be trampled upon, Fig. 95 is cross section showing how the lead is overlapped.

The wooden baton in this case may be put on of various sizes, *to suit the place*, say 3 in. broad by 2 in. high, or

2½ in. by 1½ in., or even less, as circumstances may require. It is firmly attached, by means of nails or screws, to the wood upon which it rests.

At L, Fig. 90, we see the manner in which a flat covered with lead has the lead bent over the edge of the flat. There is another way in which it is sometimes done, although I cannot express entire approval of it, especially where it breaks in upon the line of the ridge by projecting beyond it. This style, in contrast to Figs. 84 and 85, is done by




Figs. 96 and 97.

fixing on a wooden roll to the front edge of the flat, as per Fig. 96, A being the wooden roll, the dotted line B being the lead flashing put on before A, and the dotted line C being the lead of flat, which is bent around the wooden roll as shown. The lead rolls in this case, while formed as per Fig. 88, instead of being bent over as per M N, Fig. 91, are, of course, bent around the wooden roll as per D, Fig. 97. The size of this wooden roll A, Fig. 96, is about 2½ in. or *2½ in. deep, and it* projects out about 2 in.

## CHAPTER X.

### Zinc-covered Flats.

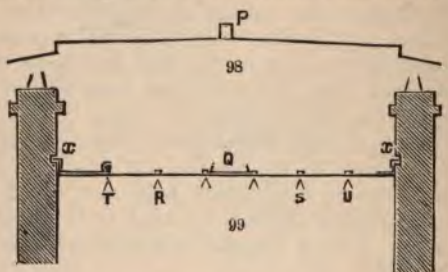
In our last chapter the manner of covering "flat" on the top of a hipped or pavilion roof with lead was described, and supposing the length of the flat had been taken at 116 ft. instead of "16," it would have been all the same as regards style, the only difference being that a greater number of pieces of lead would have been required. Had the *breadth*, however, been greater, say 30 ft. in place of "12," then a division would have been run up the centre lengthwise, something similar to what is to be explained below for zinc. And if broader still then drips would also have been put in.

In this chapter the style of using sheet-zinc in place of lead is to be described, and for illustration we shall take a flat 17 ft. long by 15 ft. broad, with a raised division running up its centre. Fig. 98 is section of such flat, P being the square wooden block or frame, 3 in. broad and 3 in. high, running up the whole length of the flat. Instead, however, of supposing this flat to be situated upon the top of a "hipped" roof, with four trapezoidal inclined sides, as was flat in former article, we shall suppose it to be bounded at the ends by two gables, in which case Fig. 99 shows longitudinal section as distinguished from longitudinal section shown by Fig. 86.

The first thing to be done here is to nail on a long narrow strip of sheet-lead, 17 ft. long by 4 in. broad, all along the front of the flat on each side, just as is shown by z, Fig. 84, then to cover the slates put on the two flashings —whether lead *or zinc*—one on each side, as shown by *dotted line, Fig. 84.* Then bend down the top half of the

lead strip, which is to form the "clinch," * as per z, Fig. 85, and then plane its edge straight.

Provision must now be made for laying down the zinc on the top of the flat; but it must be understood how wide the sheets are to be. As the general size of zinc-sheets is 8 ft. by 3 ft.,† we shall take that as the size to be used here; and as 7 in. is to be taken up by that portion of each side set up, that leaves the breadth of the sheet lying on the flat to be 2 ft. 5 in., and as this flat is 17 ft. long it will take up about seven such breadths in its length. In order to lay the sheets as regularly as possible, the first one—after one side has been set up 4 in., and the other side 3 in. high—may be placed in the centre of the flat, as at Q, Fig. 99, then all up each side wooden rolls are to be nailed




Figs. 98 and 99.

on, of which Fig. 100 shows half-sized section suitable for 2 in. zinc roll-cap; this wood-roll is 1¾ in. broad, and about 2⅜ in. high over all. The wood-roll, which extends from the central division block to the edge of the flat, need not be made all in one piece, for it may be made and fixed on more readily in two pieces by making that portion below the dotted line of a separate piece, and nailing it on first, and then nailing the larger piece on above it afterwards.

* A lead strip is recommended for the clinch, because when lead is used the clinch lies closer, and a better and neater job is therefore made.

† "Sheet-zinc is always attainable in sheets 8 ft. and 7 ft. long, by 3 ft. and 2 ft. 8 in. wide, but it may be rolled of any length under 12 ft. For specially rolled sheets about a month's notice should be given, and for lengths over 10 ft. an additional cost of about £2 per ton is incurred for rolling."—*From printed circular by Vieille Montagne Zinc Mining Company.*

We shall take this latter plan, and nail on a ⅝ inch by ½-in. piece all up each side of Q, Fig. 99; then, at a distance of 2 ft. 5 in. + ⅝ in. from each side of Q, nail on other two of these pieces, as at R S, Fig. 99, and at a similar distance nail on other two pieces, as at T U, Fig. 99. All these pieces, or wooden strips, are each 7 ft. 4½ in. long. When they are nailed on, and the seven sheets of zinc laid down in their sites, with the top *ends* of all next the central block, or division frame P, Fig. 98, set up 3 in. high (which it will be understood is independent of the one side being set up 4 in. and the other side 3 in. high), the principal portion of the wood-roll—viz., that above dotted line, Fig. 100—is then nailed on; but to nail it properly a gimblet ought to be used to bore through the wood-roll first, which causes the nail when driven down to go in where wanted. Either nails or screws may be used about 3½ in. or 4 in long. The zinc is then brought over the rolls as per dotted lines, Fig. 101, the 4-in. upstand of the one side overlapping the 3-in. upstand of the other side, as at V, Fig. 101.

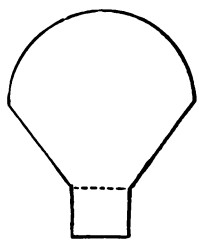


Fig. 100.

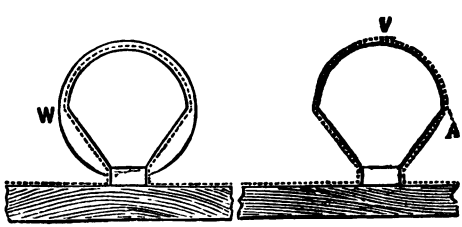



Fig. 101.

While putting on these sheets the end of the zinc next the central block, P, Fig. 98, has to be soldered at the corners. The side of the zinc with the 3-in. upstand should be soldered first, then the 4-in. one, which overlaps it, and it must be an axiom with the plumber not to solder two different sheets together, but to keep each sheet by itself. In certain cases, of course, a piece may be soldered on to the *end of a sheet to* make that sheet longer, but that is

different from joining two sheets together at the sides, or as above prohibited.

In soldering zinc, diluted muriatic acid or "spirits of salt" is used. In the *Family Herald* for March 2, 1872, I find it stated that in preparing spirits of salts for soldering it requires to stand several days in a bottle after the zinc has been put into it, and also to be shaken up every twelve hours; but that is simply a mistake, as the mixture does not require to stand even twelve minutes. In practice, the plumber pours a little of the spirits" into a small dish, say a saucer, a jelly-can, or a lead dish, set up as per Fig. 54, about 6 in. square, and say 2 in. deep, then some small pieces of zinc are put in, and in a minute or two the mixture is ready for use.

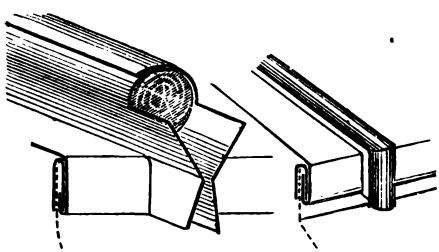
I have just made a trial of a mixture called "Baker's Preparation for Tinning and Soldering," but I find the specimen I got not to be equal to the spirits, especially when applied to old or tarnished zinc; neither did it clean the soldering-bolt half so well. The acid, as I have said above, is diluted by dissolving a little sheet-zinc in it. When the zinc is put in among the acid a violent ebullition sets in, which, however, soon subsides. If a light be put to it during ebullition the gas given off will go on burning for a short time. The soldering here is done by means of copper bolts. The acid is put on with a small piece of cane or a small brush.

After soldering the top corners of the zinc-sheet next the central block, P, Fig. 98, the front edges of the zinc-sheets have then to be clinched, as shown by K, Fig. 89; only before doing so about 1½ in. has to be cut off the end of the sheet, it being in this case that much too long. The portion of the upstand projecting beyond K is also cut away, so as to allow the zinc to be turned in. The zinc being turned in, as per K, it is then to be bent down as per L, Fig. 90; but as zinc will not work down at the corners in the same manner as lead, the upstands have first to be slit down close by the end of the wood-roll to allow the zinc to be bent down.

When clinched and bent down, as per L, Fig. 90, a small piece of zinc has to be inserted and soldered to each front corner of the zinc-sheet, and so soldered that each sheet is kept distinct and by itself. The size of this small piece is *about 2 in. square.* The two front corners of each sheet,

therefore, project out before the butt end of the wood-roll fully 1½ in., as per Fig. 102, the depth of the projection being about 3½ in. over all. The zinc roll-caps have then to be slid on as per the outer circle at W, Fig. 101, and in order to protect the front edges of the zinc-sheets projecting in front of the wood-rolls a short piece of the zinc-roll—about 4½ in.—has to be taken and put on perpendicularly, being first mitred with the front end of the horizontal zinc-roll, and then both soldered together at the mitre. The inner edge of this short perpendicular piece of zinc-roll is to be kept about ¼ in. back from the front edge of the flat, just as the bottom of the horizontal zinc-roll is raised a little above the flat.

Fig. 103 (which is drawn on a smaller scale than Fig. 102) shows the roll-cap on, Fig. 102 showing it off. The end of the zinc-roll which is next, or comes up against the central block, P, Fig. 98, has a small piece of zinc soldered round it, over which the apron of the saddle comes, so as to make all properly water-tight. The sides of the zinc-sheets which are next the gables are bent up about 3 in. high, and an apron put on, as per *x x*, Fig. 99. A pailful of clean water and a brush should then be got, and the whole of the zinc brushed over, so as to clean off all spirits of salt stains, &c.—in fact, the water and a small brush should be there all the time.

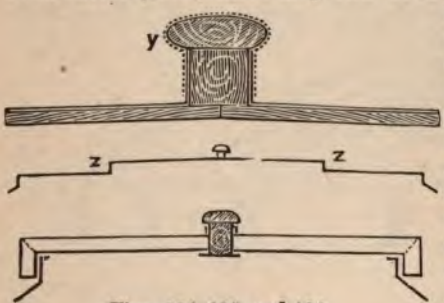


Figs. 102 and 103.

The one side of the flat being covered as above described, the same is done to the other side of the flat, and after the saddle is put on the work is finished. This "saddle" is put on as per Y, Fig. 104, the dotted line showing the section of the lead. The saddle Y, here shown, it will be understood, rests upon P, Fig. 98 ; P being also represented here as supporting Y. The wood for this saddle is 17 ft. long (the length of flat), 5 in. broad, and about 1½ in. thick. After it has been *nailed* on, and covered with lead about 1 *ft. broad, as per dotted* line at Y, the plumber-work of the

flat is finished—*i.e.*, unless the plumber has also to "point" the chasing with mastic or cement, which "pointing" in some places is left for the slater to do.

Although we have mentioned lead as the material to be used for the saddle, yet, if preferred, zinc may be used, and put on in ridge style. The zinc used for flats is of various thicknesses. No. 14 makes a pretty substantial job. A good deal of No. 12 is used, however, in practice, but to use Nos. 9 or 10, unless for a mere temporary purpose, is extremely bad, and belongs to the "scamping" system, unless indeed it is done through pure ignorance! To give sheet-zinc fair play it ought to be put on of such a thickness as that after its surface has got oxidized by exposure to the atmosphere, there may still be left sufficient body in it to keep itself together, and also duly serve the purpose for which it was put on. When this is properly attended to, zinc stands well for ridges, flats, and sides of roofs. For the latter purpose—viz., for the sides of roofs—it may yet largely supersede the use of slates, as, if properly put on, it is not so apt to be continually going out of order.



Figs. 104, 105, and 106.

In the foregoing flat, above described, the breadth is taken at 15 ft., but supposing the breadth were 30 ft., all the difference would be that twice the number of pieces of zinc would be required, as also two 4-in. drips put in—viz., one on each side, as per z z, Fig. 105.

If, however, the breadth of the flat were 23 ft. say, then the zinc would be put on just as described for Figs. 98 and 107, only as an 8-ft. long sheet of zinc would be too short, sheets 12 ft. in length would be put on; but, as these would often be difficult to get, what might be done would be to take the 8-ft. sheets, and solder on to the one end of each 4 ft. cut off another sheet, giving 1 in. or so of *overlap at the soldering*, thereby producing a sheet nearly 12 ft. *long*.

In the above flat (Figs. 98 and 107), with a slope of only 3 in. or so in the 8 ft., we have said that a little soldering was necessary at certain places, but in the case of a roof with a slope of 3 ft. or so every 8 ft., the greater part, or perhaps the whole of this soldering, could be dispensed with, as we may see in Chapter XI.

In the foregoing description of covering flat with zinc, we have taken the size of the zinc roll-caps at 2 in., but for different purposes, and in different situations, they can be had of various sizes—1¼ in., 1½ in., 1¾ in., &c. And instead of keeping the sheets the whole breadth, as above done, they may be split up the centre, which, of course, would require twice as many rolls, the distance between them being only in that case about half the above. In the above illustration we have also set up the zinc 4 in. and 3 in. high on the sides, which allows it to overlap as per V, Fig. 101, but some plumbers only set it up as high as A, Fig. 101, which may do where it is not much exposed, and the flat has sufficient slope. Instead of doing the front corners of the sheets as per Fig. 102, it has been hitherto the custom with many plumbers to solder the front edges of the different sheets together (instead of keeping them all separate as per Fig. 102), which, of course, has the effect of causing them to give way here, as they often do.

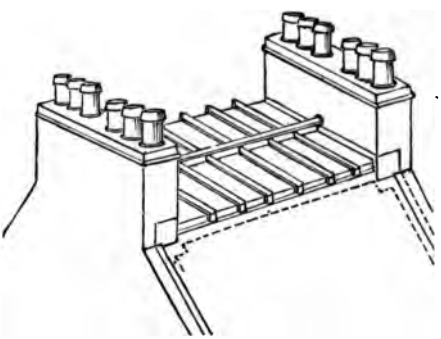


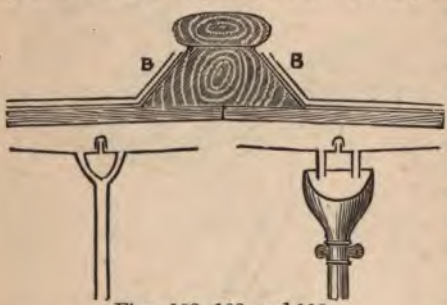
Fig. 107.

Fig. 106 is section across the flat of the zinc roll-cap, in contrast to the skeleton view of the lead-roll shown by Fig. 91; and Fig. 107 is sketch of zinc flat when finished, just as Fig. 94 showed lead flat when finished.

In covering broad flats with lead, a wooden block or frame, with saddle piece, is often run up the centre as per Fig. 104, only, as in using lead, the lead-rolls have to be turned *up against it*, as per B B, Fig. 108; the block is often

made sloping as shown, so that the lead-rolls may be turned up more easily.

While the first edition of these articles was being published in the *Building News* about 23 years ago, a considerable amount of correspondence took place about the style of laying the lead in the stone cornice gutter, explained in connection with Figs. 42 and 46 in Chapter V.; we may therefore observe that, generally speaking, the plumber has little control over the style of laying the gutters in the stone cornice referred to, as he has to make his lead to suit the channel, and in accordance with the architect's plan. If, as is often the case, the architect only allows one outlet for the rain water, and orders the gutter channel to be all inclined to one end, then the plumber is forced to lay his gutter all in one piece, as described; but if the architect allows two rain-water pipes—viz., one at each end, then the plumber can lay his gutter in two pieces with a roll, an overlap, or a saddle in the middle. And, as regards stone cornice gutters, shown in Fig. 49, if two pipes are put in, then, as in many cases, there is no necessity to lay any gutter along the front of the chimney, shown at Fig. 49, as the gutter-lead can be made to stop off at each front corner of the chimney, which causes the gutter to be in two pieces, and each piece so much shorter. Or, to take another plan, supposing the gutter channel at Figs. 42 and 46 were inclined from each end and made with a slope down towards the middle, then even with one rain-water pipe, the gutter lead could be put in in two pieces, either by using a breeches pipe, as per Fig. 109, or by letting down two short pipes into one rain-water head, as per Fig. 110.



Figs. 108, 109, and 110.

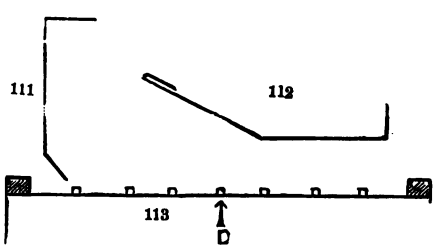
It would often tend to the greater cleanliness of the drains if the rain-water were made to discharge as much as *possible into* the high end of the drain, so as to flush all *below where it enters.*

## CHAPTER XI.

### ZINC-COVERED ROOFS.

IN Chapter X. the style of covering a flat on the top of the roof with zinc was described. In this we shall speak of covering the sides of roof with zinc. Before beginning to lay the zinc up the sides the gutters have first to be laid, and we may suppose the front one to be of the style shown in Fig. 57, while the back gutter may be of the style shown by S, in Fig. 42. These gutters may be either of lead or zinc; but as for my part I prefer lead for the gutters, we shall suppose lead to be used for the gutters here.

The apron shown at Q, Fig. 57, may be of zinc; in fact, in towns it is a good thing to have this apron of zinc, because when of lead it is often taken away, and it is better, therefore, to lock the door before the steed is stolen than after it has vanished. In order to stiffen it, the lower or outer edge of the zinc apron, or flashing, has to be set in a little, as per Fig. 111.



Figs. 111, 112, and 113.

In setting up sheet-zinc to the sizes and shape necessary to make it fit its intended site, it is turned over the edge of an iron-faced bench; or if, as is often the case, the zinc is set up at the job, then in many cases a long, stout, sharp-edged wooden plank is made to serve the purpose in lieu of the bench *proper*.

In the sketch of gutter at Fig. 57, the wooden fillet or "doubling" for slates is shown at the top edge of the lead; such "doubling," however, is dispensed with here, as in this case we are not to have any slates. The style of the roof is the common gable, or "pent" roof, and, for illustration, we shall suppose it to be 10 ft. long between the skews (the reason why we suppose the length to be only 10 ft. is in order to economise the space for engravings, and the principle can be shown all the same with a length of 10 ft. as with one of 100 ft.), the depth of the roof from the ridge to the gutter channel being, we shall say, 15 ft.

Before doing anything else to the roof, the whole of its surface ought to be examined to see if there are any nails, &c., projecting above the surface, and if there be any such thing they must all be well punched down. The gutter being laid, and its top edge next the slope of the roof bent over about 2 in., as per Fig. 112, the number and site of the rolls must then be fixed.

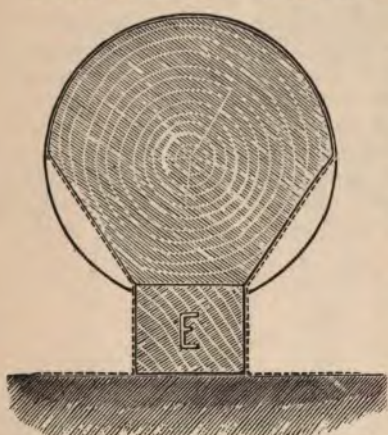
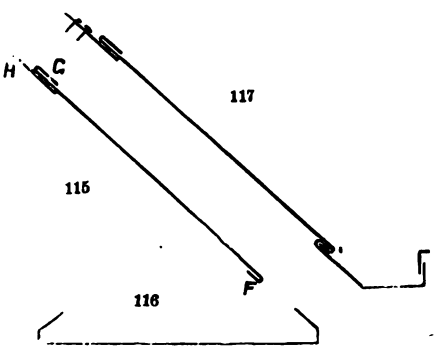


Fig. 114.

As the length between the skews is 10 feet, and the 8-ft. by 3-ft. zinc-sheets are all to be cut up the middle longitudinally, it follows that there will be seven rolls, and also eight sheets in the length of the roof. The site for the first roll may, therefore, be marked off in the centre of the roof, as per D, Fig. 113. The full breadth of our zinc-sheets, after being cut up, being now 1 ft. 6 in., it follows that as 1½ in. is to be allowed for the upstands on each side of the sheet there will only be a distance of 1 ft. 3 in. between the rolls, as also that the number of the rolls required will, as we have said above, be seven, as shown on Fig. 113. As the size of the zinc-roll caps is in this case to be 1½ in., Fig. 114 *shows full-sized* section of wood-roll suitable for same.

(The outer circle, shown on Fig. 114, is full-sized section of zinc-roll cap, and the dotted lines show the zinc-sheets as turned up against the wood-roll.)

The wood-roll, Fig. 114, is about 1⅜ in. broad by 1⅞ in. high over all. It is best to be made and put on in two pieces as described for 2-in. rolls at Fig. 100. We, therefore, nail on the long strip E, Fig. 114, first, in the centre of the roof, as at D, Fig. 113, and at the distance of 1 ft. 3 in. from each side of it nail on other two pieces, and 1 ft. 3 in. from them other two, and 1 ft. 3 in. from the latter other two; in all, seven strips, as shown by Fig. 113. After these long wooden strips are nailed on (as they extend from the gutter up to the ridge, the length of each is about 15 ft.), the zinc has to be turned in at the bottom 1 in. as per F, Fig. 115, and also turned down at the top 2 in., as per G, Fig. 115. The sides of the sheets have then to be set up 1½ in. on each side, as per Fig. 116.

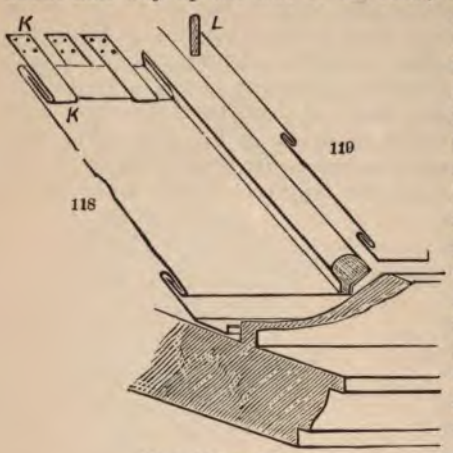



Figs. 115, 116, and 117.

After this is done a small strip of zinc about 6 in. long by 3 in. broad is firmly soldered on to the under side of the sheet at the top, as at H, Fig. 115; it is to be put on in the centre of the width, and its purpose is to support the sheet, and keep it from slipping down after said sheet has been put into its place. When the zinc sheet is put into its place three or four flat-headed nails are driven through the upper half of H, thereby fixing H to boarding, and so suspending the sheet.

The lower portion of the sheet, turned in as per F, Fig. 115, it will be understood, laps on to the top edge of the gutter, which was turned down to suit it, as per I, Fig. 117. Besides zinc latchet H, Fig. 115, two other zinc "clips," about 6 in. long by 2 in. broad, are put on for top of each sheet, one at each side of H. They are merely nailed to boarding and *turned into* top of sheet, as per K K, Fig. 118.

The eight sheets on the lower half of the roof next the gutter being thus laid—except the two outside sheets next the gables J J, Fig. 113, which may be set up 2 in. or 2½ in. on the side next the gable—it is seen that they only go about half-way up the side of the roof; consequently other eight sheets, each 18 in. broad, have to be taken, and their bottoms turned in as per F, Fig. 115, and their sides set up, as per Fig. 116, while their tops may stop off at the ridge, as per L, Fig. 119. Or, for another style of finish, the tops of the sheets may be set up against the ridge. The latchets H, Fig. 115, are to be soldered on for the top sheets, just as mentioned above for the others. It may be here pointed out that Fig. 119 is shown at half the size of scale of Fig. 118.



Figs. 118 and 119.

The other side of the roof being also laid in a similar manner, and the wooden rolls all fixed on between the sheets, as per Fig. 120, the zinc roll-caps (which I may here mention are generally machine-made) are then slid down over them, as per M, Fig. 121. But as these zinc roll-caps are generally in 8-ft. lengths, while the side of the roof is 15 ft. deep, it follows that there must be a joint in each stretch of roll-capping, which joint is simply made by slipping *the upper roll-cap* an inch or two over the lower one, and

Fig. 120.

Fig. 121.

also soldering it. One nail or small catch put in under the joint at the top of each roll-cap is sufficient to hold the roll-cap in its place, as, if properly put on, the zinc roll-cap grasps the roll below it firmly.

In order to allow the zinc roll-caps to be slid on, a small bit of the wood of the ridge may have to be cut out, but if so it does no harm, and may be replaced. Where the work is properly done these zinc roll-caps fit like a glove, both allowing the zinc underneath them to expand, and at the same time holding it.

After the roll-caps are on the ridge must then be covered. It makes a very neat and tradesmanlike job to put on a good lead ridge of 6 lb. or 7 lb. sheet-lead, about 15 in. broad, which can be nicely worked over all the rolls, and allowed to come down the roof several inches, so as to give sufficient overlap. Fig. 122 shows perspective view of the roof when finished.

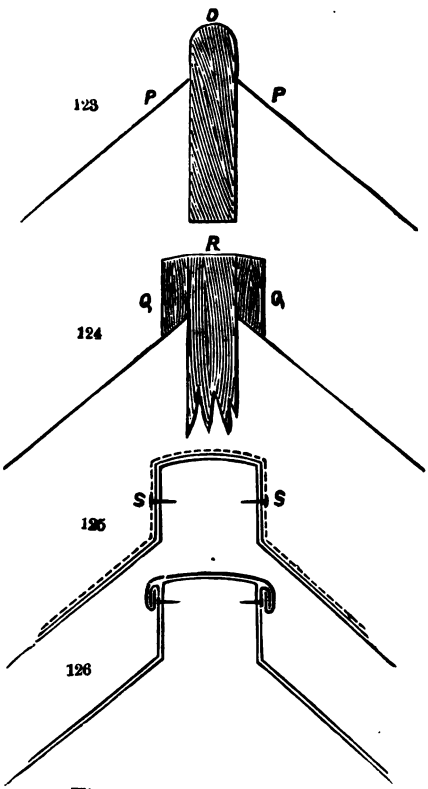
Fig. 122.

In the beautifully-got-up and useful illustrated pamphlet on "Zinc as applied to Roofing Purposes," issued by Messrs. Braby & Co., it is stated that Mr. H. G. Austin, architect to Canterbury Cathedral, had covered the cloister-roof with zinc, thirty-three years ago, with lead capping, and it had stood so well that he intended to use it further. This employment of the "lead-capping," therefore, agrees with our recommendation as above given of lead for the ridge.

Another way to finish the ridge would be one which I would respectfully call the attention of architects and builders to, as it could easily be adopted and used for roofs which are covered with slates, to the great saving of the slates from breakages from the feet of sweeps or other parties who have occasion to walk along the top of the roof.

Fig. 123 shows common style of ridge, the centre-piece projecting up about 3 in. or so above the sides. In this case the wood being only 1½ *in.* or 2 in. broad, and also round at the *top, parties walking* along cannot very well walk on

the top of the ridge, as at O, and so the feet are put dov on each side, as at P P, thus perpetually causing the slat to be broken there. Now if the top of the ridge at o we more flattened, and also two strips of wood, about 1 i thick and about 3 in. deep, were taken and nailed on, o on each side of t ridge, as per Q Fig. 124, then pe ties having occ sion to be on t roof could easi walk along the t of the ridge without requiri to touch the slat at all.




Figs. 123, 124, 125, and 126.

To cover th form of ridg where slates a used, the zinc m be put on as p Fig. 125, th dotted line bei galvanised ir straps, put every 2 ft. 6 in. so. Or, anoth plan would be put on a flashi —either lead zinc — on eac side, and a seps ate piece for th top, as per Fi 126. Or, again, we turn back Figs. 74 and 74 the hook-and-e system there depicted—formerly designated "Fox's Pate Underlock Fastening," but which patent must now ha expired here—may be used; the hooks being driven in each side of the ridge where the nails S S, Fig. 12 *are shown, and* the eyes soldered on to the inside

the zinc ridge; or *vice versâ* as shown at Figs. 74 and 74a.

It will be observed that the tops of the ridges, Figs. 125 and 126, and at R, Fig. 124, are not flat, but that they are slightly convex, the rise in the centre in the actual size of the ridge being fully ¼ in.; or, in other words, the top of the form of ridge we are referring to is the arc of a circle 14 in. in diameter, of which the chord is 4 in.

The shape and style of the rolls given here as per Fig. 114, and in Fig. 100, were not included in the pamphlet "Zinc as applied to Roofing Purposes," issued under the auspices of the architects and engineers to the London manufacturing agents of the Vieille Montagne Zinc Company; but as we not only highly approve of it, and it also has a fine appearance and makes a good job, we could not do otherwise than show it as has been done, more especially, too, as it has for some time back been largely used.

The style of overlapping the zinc on the top of the rolls shown by the dotted lines, Fig. 101, Chapter X., is the maximum for setting up the sides of the sheet; but in thousands of cases, and unless the customer wishes it otherwise, the zinc at the sides of the sheets needs only to be set up about half-way up each side of the roll, as shown by Figs. 114 and 120 above. This is especially the case where there is a good slope, and no danger from half-melted snow lying.

Messrs. J. & R. Fisher, the architects of the Zinc Company above referred to, in a note to us, recommend the style of roll shown by Fig. 127, which is certainly very plain, and which we will admit may, perhaps, be a little cheaper at first cost and easier to put on than the style at Fig. 114; but we can hardly admit that it either makes a better job or looks so well.

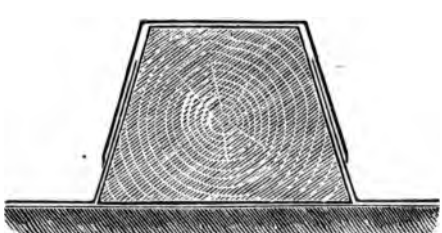
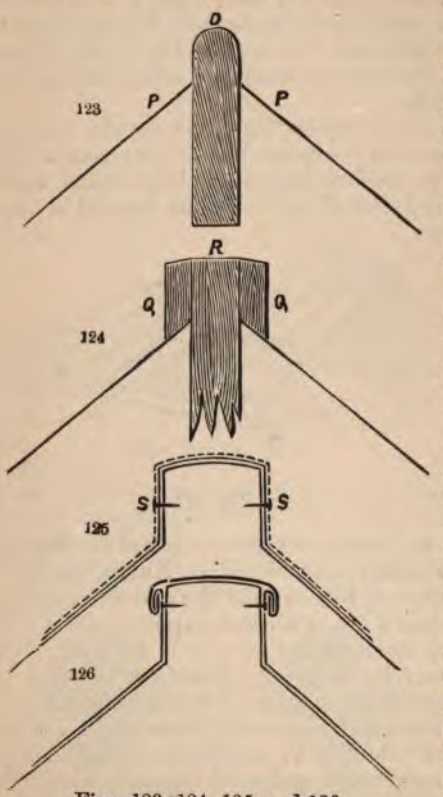


Fig. 127.

However, where there are many men there are many minds, *so there is plenty* of scope for both plans. Fig. 127

the top of the ridge, as at O, and so the feet are put down on each side, as at P P, thus perpetually causing the slates to be broken there. Now if the top of the ridge at o were more flattened, and also two strips of wood, about 1 in. thick and about 3 in. deep, were taken and nailed on, one on each side of the ridge, as per Q Q, Fig. 124, then parties having occasion to be on the roof could easily walk along the top of the ridge R without requiring to touch the slates at all.




Figs. 123, 124, 125, and 126.

To cover this form of ridge where slates are used, the zinc may be put on as per Fig. 125, the dotted line being galvanised iron straps, put on every 2 ft. 6 in. or so. Or, another plan would be to put on a flashing —either lead or zinc — on each side, and a separate piece for the top, as per Fig. 126. Or, again, if we turn back to Figs. 74 and 74a, the hook-and-eye system there depicted—formerly designated "Fox's Patent Underlock Fastening," but which patent must now have expired here—may be used; the hooks being driven into *each side of* the ridge where the nails S S, Fig. 125, *are shown, and* the eyes soldered on to the inside of

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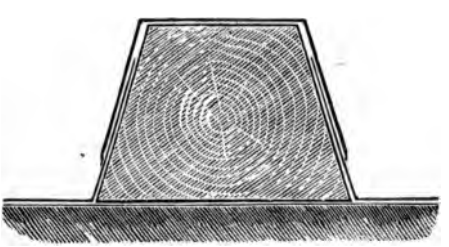


Fig. 127.

However, where there are many men there are many minds, *so there is plenty* of scope for both plans. Fig. 127

is known as the "French Plan," and if there be no objections, Fig. 114 might be called the *British* Plan.

Another plan of roll is that shown by Fig. 128, with five zinc clips 2 in. broad, in the length of the sheet, put under the wood-roll and turned down as shown. This appears to be an improvement upon Fig. 127, but to our mind it could be greatly improved by being rounded at the top and also contracted a little more at the bottom, which would enable zinc roll-cap to take a firmer hold of the roll, and also suit the purpose better. The style of Fig. 127 also requires zinc clips put under the wood-rolls, as shown in Fig. 128; none such are required for Fig. 114, as the style of the wood-roll renders them unnecessary.

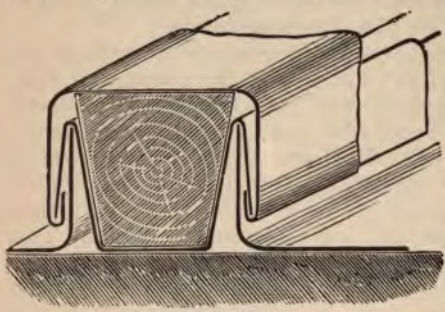


Fig. 128.

The style of roll and shape of roll-cap at Fig. 114 are also unfavourable to capillary attraction having scope. Fig. 129 shows "patent wood-roll with zinc drawn over by machinery." It is 2 in. high, and $2\frac{3}{4}$ in. broad. We cannot say that we consider this style any improvement upon Fig. 128; it is, however, a variety. In Fig. 129 we would be afraid of snow or heavy rain being blown in at the sides of the roll, and so rotting the wood, especially where the roof was very flat.

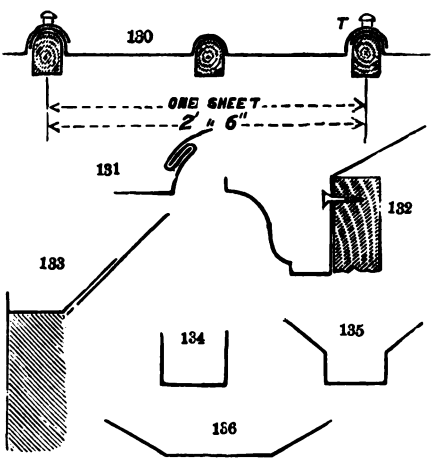
Fig. 129.

*In the foregoing* styles of laying or putting on zinc, *it will be understood* that the roofs underneath the

zinc are boarded—*i.e.*, that the zinc lies on wooden boards.

In what is known as "Italian corrugation," no boards are used, wooden rolls 3 in. deep by 1¾ in. broad being put in every 1 ft. 3 in., centre to centre, and purlins fixed every 10 ft. or so. The overlap at the top and bottom of the sheets is about 4 in., and the screw nail ought not to be put in through both sheets. Fig. 130 is section of this style. The fold in Fig. 131 is an improvement upon the mere overlaps of Fig. 130, especially where the roof is much exposed. For roofs without boards, No. 15 and 16 zinc ought to be used.

The style of roll at Fig. 127, and the overlap at T, Fig. 130, are something similar to the manner in which lead is put on for flats, &c., in many parts of England and Ireland, but neither can for a moment compare to the style of roll shown by Fig. 88; we would, therefore, respectfully recommend the style of laying lead on flats described in Chapter IX. as being much better than the styles where wood is used for the rolls, especially where the rolls are not liable to be trampled upon.




Figs. 130, 131, 132, 133, 134, 135, and 136.

The gutters for these zinc-covered roofs may be of many patterns similar to those we have already described; and, in addition, we have the zinc eave-gutter (Fig. 132), which may contain various enrichments in stamped zinc; the boundary-wall gutter (Fig. 133); the plain "box-gutter" (Fig. 134), or the same with sloping sides, as per Fig. 135, for the centre-gutter *on double* roofs. Fig. 136 is the common style *of centre-gutter on double* roofs in the south-west of Scotland.

In using zinc for roofs there are two situations in which it does not stand so well—viz., quite close to the seaside and where it is much exposed to the fumes from chemical works; but these are exceptional situations. In the latter case a coating of white-lead paint helps to protect the zinc. In the neighbourhood of the St. Rollox chemical works at Glasgow we have seen that side of a zinc ridge which was next the chemical works wholly eaten away, while the off side was still pretty good.

In the article on "Zinc" in Gwilt's "Encyclopædia of Architecture," we are told that zinc is much more used in France than in England, and it goes on to say:—"Zinc, though subject to oxidize, has this peculiarity, that the oxide does not scale off as that of iron, but forms a permanent coating on the metal, impervious to the action of the atmosphere, and rendering the use of paint wholly unnecessary. Its expansion and contraction is greater than those of any other metal; thus, supposing 1·0030 to represent the expansion of it. 1·0019 is that of copper, and 1·0028 that of lead; hence, in use, proper attention must be paid to this circumstance, or a substantial and durable covering of zinc will not be obtained. The method of accomplishing this is, of course, by always allowing plenty of *play* in the *laps*. The tenacity of zinc to lead is as 16·616 to 3·328, and to copper as 16·616 to 22·570; hence a given substance of zinc is equal (in tenacity) to five times the same substance in lead, and about three-fourths of copper."

As explained in connection with Figs. 102 and 103, Chapter X., and as just observed, zinc ought to be allowed "plenty of *play*." Instead of doing so, when covering flats, we have observed in our travels that many plumbers carefully solder all the sheets together where they bend over the front edge of the flat. Now, seeing this is not "according to Cocker," we object to it, as in a short time the zinc gives way at the solderings; therefore, either overlap the sheets properly at the front of the rolls, or else finish as shown in Fig. 102.

The gauges of zinc recommended for roofing purposes are Nos. 13, 14, 15, and 16. The following tables of some of the gauges, and their corresponding weights, may be useful. The weights given are not absolutely correct, there being *slight variations* in the weight of sheets of the same gauge,

some being a little heavier than as given in the table, others a little lighter:—

| No. 1, Old Tariff. | | | No. 2, Newer Tariff, A.D. 1878. | | | |
|---|---|---|---|---|---|---|
| Sheet-zinc gauge. No. | Weight per sq. foot. oz. dr. | | Sheet-zinc gauge. No. | Weight per sq. foot. oz. dr. | | Weight of Sheet 8 ft. by 3 ft. lbs. oz. dr. |
| 8 .. | 9 0 | | 8 .. | 9 2 | .. | 13 11 0 |
| 9 .. | 10 13 | | 9 .. | 10 5 | .. | 15 7 8 |
| 10 .. | 12 8 | | 10 .. | 11 7 | .. | 17 2 10 |
| 11 .. | 15 0 | | 11 .. | 13 5 | .. | 19 15 8 |
| 12 .. | 17 5 | | 12 .. | 15 2 | .. | 22 11 0 |
| 13 .. | 19 5 | | 13 .. | 16 15 | .. | 25 6 8 |
| 14 .. | 21 12 | | 14 .. | 18 12 | .. | 28 2 0 |
| 15 .. | 24 0 | | 15 .. | 21 12 | .. | 32 10 0 |
| 16 .. | 26 0 | | 16 .. | 24 12 | .. | 37 2 0 |
| 17 .. | 30 0 | | 17 .. | 27 11 | .. | 41 8 8 |
| 18 .. | 34 13 | | 18 .. | 30 11 | .. | 46 0 8 |
| 19 .. | 39 2 | | 19 .. | 33 11 | .. | 50 8 8 |
| 20 .. | 43 7 | | 20 .. | 36 10 | .. | 54 15 0 |

Parties wishing further information about the use of zinc for roofing purposes, in connection with the walls and timbers, &c. (as zinc is lighter than slates, thinner walls and slighter roofs may often serve), may obtain it from the architects specially retained by the Vieille Montagne Zinc Company—viz., James Edmeston, Esq., 5, Crown Court, Old Broad Street, City; or Messrs. J. and R. Fisher, 17, Great George Street, Westminster.

In the foregoing tables the weights of sheet-zinc were given; in this case we add a table of its approximate thickness, according to No. 2 Tariff:—

| Sheet-zinc gauge. No. | Birmingham wire gauge. No. | Thickness in decimals of an inch. | Parts of inch. |
|---|---|---|---|
| 9 .. | 26 .. | ·017 = | 1-58th |
| 10 .. | 25 .. | ·019 = | 1-52nd |
| 11 .. | 24 .. | ·022 = | 1-45th |
| 12 .. | 23 .. | ·025 = | 1-40th |
| 13 .. | 22 .. | ·028 = | 1-35th |
| 14 .. | 21 .. | ·031 = | 1-32nd |
| 15 .. | 20 .. | ·036 = | 1-28th |
| 16 .. | 19 .. | ·041 = | 1-24th |
| 17 .. | — .. | ·0459 = | 1-22nd |
| 18 .. | 18 .. | ·051 = | 1-20th |

The exact decimals of an inch of the Birmingham wire-gauge I understand to be:—

| *26* | *25* | *24* | *23* | 22 | 21 | 20 | 19 | 18 |
|---|---|---|---|---|---|---|---|---|
| *·018* | *·020* | *·022* | *·025* | ·028 | ·032 | ·035 | ·042 | ·049 |

A square foot of zinc, 1 in. thick, weighs 600 oz., or 37½ lb.; from above table we therefore see that No. 12 zinc, *e.g.*, is ·025 or 1-40th of an inch thick, and that it would therefore require 40 thicknesses of it to make up 1 in. Then, if we turn to page 73, we find from the table there that No. 12 zinc weighs fully 15 oz. to the foot. Now, if we multiply 15 oz. by 40, we get 600 oz., or 37½ lb. Or, again, taking No. 14, we see it is ·031, or 1-32nd thick; then, as per page 73, multiply the 18¾ oz. there given for No. 14, by 32, and we also get 600 oz., which shows that it requires 32 layers of No. 14 sheet-zinc to make up 1 in. in thickness. Then to get the weight of one cubic inch of zinc, divide the 600 oz., above given, by 144, and we get 4⅛ oz. as the weight of a cubic inch of zinc. I may add here the two following rules from Messrs. Braby & Co.'s circular, which may be useful:—

Rule to obtain contents of any square or oblong tanks.—Multiply the length by the breadth, and the product by the depth; the result multiplied by 6¼ gives contents in gallons.

Rule to obtain contents of round cisterns or tanks.—Multiply the diameter by itself in inches, and the product by ·7854, then multiply this product by the depth in inches, and you get the number of cubic inches. There are 277¼ cubic inches in a gallon of water; so that, *e.g.*, a cistern 18 in. diameter, and 3ft. high, would contain, approximately, 33 gallons, 277¼ being used as the divisor.

A cubic foot of lead weighs 11,352 oz., or 709½ lb. (water at 40° Fahr. weighs 1,000 oz.). A square foot of lead, 1 in. thick, will, therefore, weigh 59⅛ lb.; but suppose we call it 60 lb., we get the following thicknesses for the following weights of sheet-lead:—

| Weight per sq. ft. in lb. | Parts of an inch. | Decimals of an inch. |
|---|---|---|
| 10 | 1-6th | ·169 |
| 8 | 2-15ths | ·135 |
| 7½ | 1-8th | ·126 |
| 6 | 1-10th | ·101 |
| 5 | 1-12th | ·084 |
| 4 | 1-15th | ·067 |
| 3 | 1-20th | ·050 |

A cubic inch of lead weighs fully 6½ oz., and as we said above that a square foot, 1 in. thick, weighed 59 lb., or *944 oz.*, a circular slab, 1 ft. in diameter and 1 in. thick, would *weigh fully 735 oz.*, and a lead circle piece, 1 in. diameter

and 1 in. high, weighs 5 oz. and one-tenth. To get this latter, multiply $6\frac{1}{2}$ oz. by ·7854; and to get the 735 oz. for circular slab 12 in. in diameter, square the diameter, and multiply by ·7854, which gives number of cubic inches, then multiply by $6\frac{1}{2}$ for number of ounces. Again, if circular slab were cylinder 10 in. high, then $12 \times 12 \times \cdot7854 \times 10 \times 6\frac{1}{2} = 7{,}351$ oz., or more correctly, $12 \times 12 \times \cdot7854 \times 10 \times 6\cdot569 = 7{,}430$ oz.

To get area of a right-angled triangle, multiply the base by half the height; thus, base 4 ft., perpendicular 4 ft., gives $4 \times 2 = 8$ ft., which 8 ft., it will be observed, is exactly half the area of a square 4 ft. in the side. To get the area of the trapezoid, Fig. 136A, multiply the base by half the sum of the perpendicular sides; thus, if the base be 12 in., and the sides 9 in. and 3 in., we say 9 in. + 3 = 12, half 12 = 6; then $12 \times 6 = 72$ in., or half a square foot.

A simple portable or pocket gauge, capable of accurately indicating at a glance the thickness and weight of sheet-lead, zinc, and other metals, has long been wanted, yet I have neither seen nor heard of such an article in the market yet.

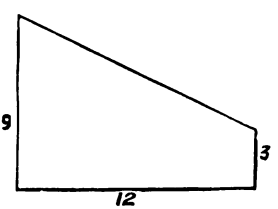


Fig. 136A.

There are two sorts of gauges sold, viz., one with slots and another with a screw, but they do not seem to suit the purpose properly. To meet this want I took out provisional protection for a simple instrument which I termed the "metro-multiplier," or magnifying gauge, as it magnified the real thickness of the article gauged ten or twenty times or so, and thus the eye could easily distinguish on the scale the small differences between the various thicknesses of zinc-sheets. I had a rough one made of zinc about twenty years ago, and it served well; then, as it had been asked for publicly, I tried to get it up in steel, but could not find a manufacturer for it in that metal, the excuse being fear that it would not pay.

## CHAPTER XII.

### Snow-Boards.

In gutters, such as Figs. 52 and 57, and also in centre-gutters, such as Fig. 136, &c., annoyance is sometimes felt from half-melted snow filling them up. As a precaution against this, snow-boards of the style shown in Fig. 137—which gives cross section of same—are often laid down.

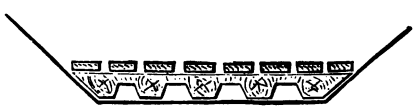


Fig. 137.

They are formed by bars of wood, about 5 in. deep and 2 in. or more thick, being placed across the gutter 3 ft. or 4 ft. apart. In the under side of these bars several checks, about 3 in. deep and 4 in. to 6 in. wide, are cut out for the passage of the water. Above these cross-bars longitudinal pieces of wood, about 3 in. or 4 in. broad and about $\frac{7}{8}$ in. thick, are fixed about 1 in. apart from each other.

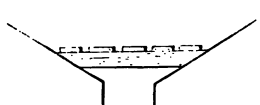


Fig. 138.

Fig. 138 is another style without checks in the cross-bars, so that these latter cross-bars need only be about 3 in. deep. Fig. 139 is cross section of a style which serves both as a snow-board and as a preventive of broken chimney cans, loose slates, &c., falling over the roof. A long *board, w, say 7 in.* or so broad, and about 1 in. or 1¼ in. thick, *is made to run along* the whole length of the roof, its lower

edge a little above the slates. This board is fixed to, and kept in its place by, a number of pieces of iron shaped like the letter L, as per x, Fig. 139. The pieces of iron (made, say, of malleable iron, 2 in. broad and $\frac{3}{8}$ in. or so thick), which may be about 16 in. long over all—10 in. for lying

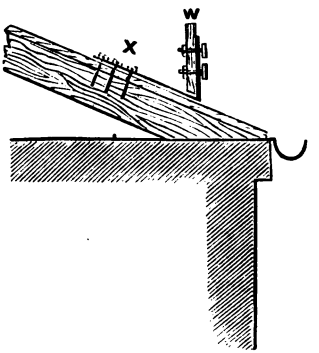



Fig. 139.

on the roof and 6 in. for the upstand—may be put on from 3 ft. to 4 ft. 6 in. or so apart; they may be fixed to the roof with strong iron or brass screws, while $\frac{3}{8}$-in. bolts and nuts may be used to fix the snow-board to the iron, all as per w x, Fig. 139. A piece of sheet-lead is put over the inclined portion of the iron lying on the roof.

## CHAPTER XIII.

### Hatches, Windows, and Domes.

Before leaving the roof there are several things that must be referred to.

We have described gutters, flashings, valleys, ridges, hips, and flats on roof, and we shall add a few words about hatches and windows. The simplest form of hatch on roof is known as the sliding-hatch, of which Fig. 140 shows longitudinal section. All the plumber-work required about it is the piece of lead, or zinc, E, along its top, and the sole, F, along its bottom. E will be about 10 in. broad, and if the hatch be 18 in. wide, E will be 2 ft. 6 in. long. F will be about 18 in. broad, and about the same length as E. The sliding board $E^2$, Fig. 140, is made out of a wooden board about 1 in. thick. Its length may be about 3 ft., or rather more, and its breadth the distance between the rafters. There ought to be a hole cut in its centre, about 9 in. or so long and 6 in. or so wide, in order to admit light; over this hole a piece of strong glass is put as per $F^2$, *Fig.* 140.

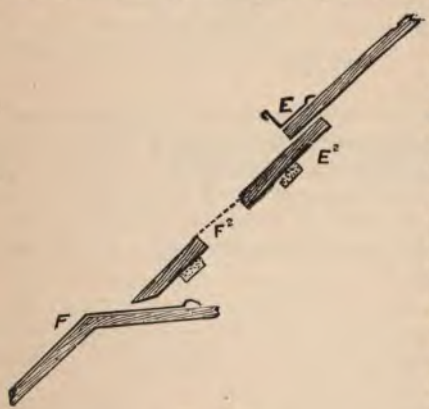
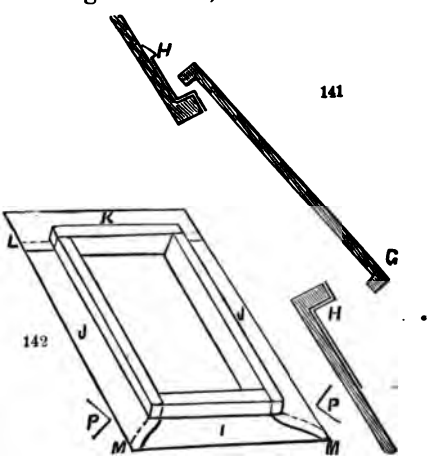



Fig. 140.

*This is a very* serviceable form of hatch, and also less

expensive than the one which follows; there are no hinges about it to break, &c., and where a hatch is merely used for the purpose of chimney-sweeps and tradesmen getting access to the roof, I prefer it when well made to any other I remember of at present.

Another form of hatch is that with hinged lid, of which Fig. 141 shows longitudinal section, with lid G partially open, the lines at H H being the top and bottom lead-flashings. If we suppose the daylight of this hatch to be 18 in. wide and 2 ft. 6 in. long, then, as the wooden frame is about 3 in. deep and 2 in. thick, its breadth over all will be 22 in., and its length over all, 2 ft. 10 in. The lead for this has to be cut out in four pieces, the breadth of all being 6 in. + 3 in. + 2 in. = 11 in., and the length of bottom piece, I, Fig. 142, 22 in. + 6 in. + 6 in. = 2 ft. 10 in. The length of two side-pieces, J J, Fig. 142, is each 2 ft. 10 in. + 7 in. = 3 ft. 5 in., and the length of top-piece, K, Fig. 142, 22 in. + 7½ in. + 7½ in. = 3 ft. 1 in.



Figs. 141 and 142.

The top-piece of lead, K, is cut out longer than the bottom-piece, I, because the former has to be wrought down and around the top corners of the frame as far as L, Fig. 142, the dotted line above L showing the position and amount of the overlap which the top-piece, K, has over the two side-pieces J J, the dotted line being top of J, and showing how far the side-piece, J, goes up under the top-piece, K. M M, Fig. 142, again show how the two side-pieces, J J, overlap the bottom-piece I, the two side-pieces at the bottom being worked around the lower corners of the frame something similar to the way in which the top-piece, K, is *wrought round* the upper corners.

After the lead has been cut out, to sizes stated, the plumber first sets it up as per Fig. 143, in this case allowing 3 in. + 2 in. = 5 in. for the upstand. If it be a slated roof, a board about ½ in. thick has to be put temporarily in front of the bottom of the hatch-frame, so as to allow for the thickness of the slates, just as was previously mentioned for barges, at Fig. 46, Chapter V. The lead being set up as per Fig. 143, is put against the frame, as per Fig. 144, and then dressed over, as per Fig. 145, two or three nails being put in as at N, Fig. 145, to hold it. Of course, as will be seen from Fig. 142, which shows perspective view of the hatch with the lead on, the bottom-piece, I, has to be put on first, and simply cut away at the corners as per dotted lines above M M. The two sides are then put on, and last of all the top. After this the wooden "doubling" has to be put along the top, as per O, Fig. 146, and down the sides, as far as P P, Fig. 142.

Fig. 143.

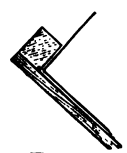


Fig. 144.

Such is the manner of putting lead around this sort of hatch, and if zinc is to be used it may also be done in the same manner, except that instead of working the zinc round the corners in the same way as with lead, the zinc has to be cut at the corners, pieced, and soldered. It is only the top and bottom pieces that require piecing and soldering, and said soldering, &c., is to be done on each piece *per se*.

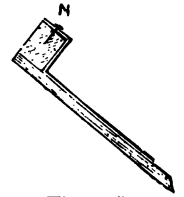



Fig. 145.

Owing to the way the bottom-piece of zinc is made and slipped up, the sides J J, Fig. 142, when zinc is used, instead of being each 3 ft. 5 in. long, as above shown for lead, need only be 2 ft. 10 in. long, or the same length as the frame, as per Fig. 147, where the two sides, Q Q, are seen to extend from R to S, the dotted line at R showing how far the side-piece Q is slipped up under the top-piece T, and the other dotted line near S, showing how far *the bottom-piece*, U, Fig. 147, is slipped up under the side-*pieces, Q Q.*

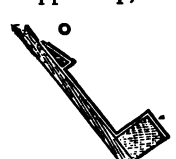
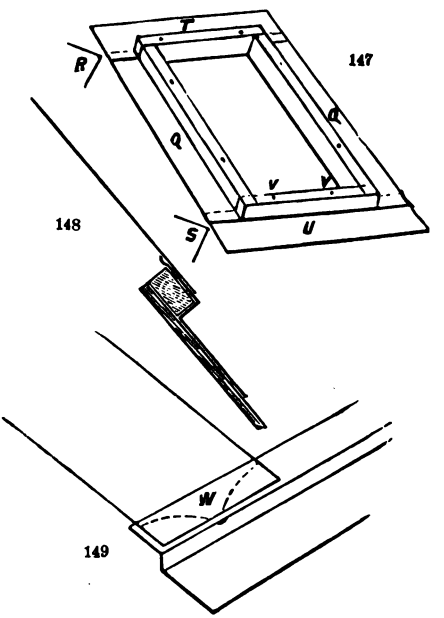



Fig. 146.

In setting up the bottom-piece, U, if roof is to be slated, the plumber must remember to allow ½ in. or so for the thickness of the slates which are to go under U. This bottom-piece, U, is only fitted in temporarily at first, until the slates are put on, so that the slater may lift it out to get his slates nailed, for zinc cannot be bent up and down in the same easy manner as lead. After the slater has finished, the bottom-piece, U, is slipped up and nailed to the frame in the same way as for lead at N, Fig. 145, and as per V V, Fig. 147. When desired the zinc can be put on to return round the corners as at M M, Fig. 142, the zinc being left so much longer and a soldering made at each corner; but the sides not soldered to the bottom, however.



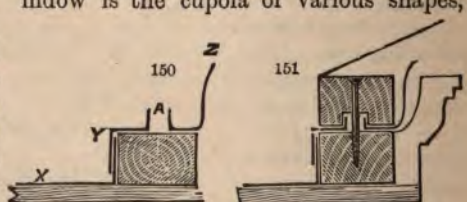

Figs. 147, 148, and 149.

I have been thus particular in explaining the modes of putting lead and zinc round this latter form of hatch because the principle in it is, in great measure, the same as that in use for many sky-light windows, there being only a little difference in detail, such as that the wooden frame may be higher and broader (which, by the way, may also be the case with hatches), the tops and sides may be longer and deeper, &c., and also, in the case of windows, the lead is allowed to come over on the glass (unless in the case of movable windows) about ½ in. at top and sides; and at bottom it goes up under the glass according to the shape of the frame, *so as to catch* the condensed water which runs

down the inside of the glass, and by carrying it outside, thus prevent it running down the inside, and so making those unsightly, dirty marks often seen where the lead or the zinc is improperly put on. The lower portion of the glass ought not to rest closely on the lead unless a channel or channels are cut out of the wood underneath, into which the lead has been dressed, so as to allow the condensed steam or water to get freely away.

Fig. 148 shows section of the lead going up under the glass, and Fig. 149 is sketch showing how the channel for the water may be left in the centre of each pane, the dotted line being the top of the putty, $\frac{1}{8}$ in. in thickness, which both keeps the glass off the lead and also prevents the wind in an exposed situation getting in under the pane and perhaps either blowing it off or breaking it. Or, again, if the joiner were cutting that much out of his wood at W, Fig. 149, the same purpose might be served without the putty, or some other plan might be adopted to suit the circumstances and the form of window. The distance which the lead goes up under the glass, or which the glass overlaps the lead at W, Fig. 149, is generally, for a good job, 3 in. On a roof where the incline is small, if the glass is not put on as at W, Fig. 149, and 3 in. or more of overlap given, capillary attraction, or the wind blowing, causes the rain to come in.

Another roof indow is the cupola of various shapes, round, square, and oblong. In many cases these cupola windows are brought and put on after the plumber has finished. Fig. 150 shows section of one side before the window is put on, and Fig. 151 after window is on. X, Fig. 150, is the lead or zinc gutter; Y is lead apron overlapping the upstand of the gutter as shown, bending horizontally across the block or underframe, upon which the window-frame is to rest, and then up to Z as shown.



Figs. 150 and 151.

The upstand at A, Fig. 150, is one of the small lead pipes *(say), 4 in. high and* the same in diameter, which are soldered

to the lead apron, and down through the centre of which the screws to fasten down the window-frame are put, as per Fig. 151. In many cases small grooves or channels are cut across the bottom of the upper wooden frame for the outflow of any condensed water off the inside of the glass.

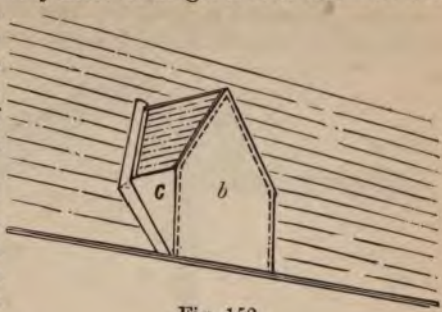



Fig. 152.

In putting lead aprons round circular windows the lead has to be dressed to fit the circle; one plan is to roll up the piece of lead apron and dress in the top side of it as if contracting a lead pipe; when this has been done to one end of piece, unroll it and then roll it up again, keeping the already contracted end inside, and so make both ends alike, and in this manner make the piece of lead fit the circle.

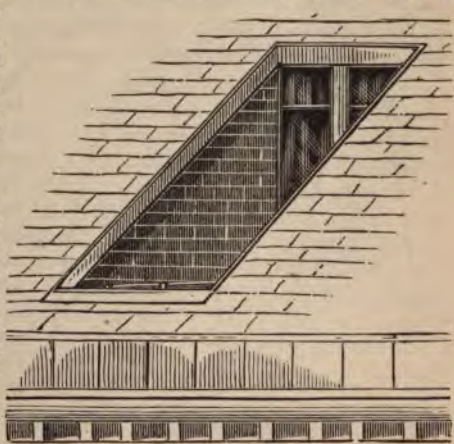


Fig. 153.

The dormer (from the French *dormir*, Latin *dormire*, to sleep; these being generally the windows of the bedrooms or sleeping apartments), or projecting window B, Fig. 152, is another roof window with a flashing and valley going up each side and a ridge along the top, there being also a large triangular apron on each side, as shown at C, Fig. 152. The sketch supposes zinc sides, C, and ridge, and lead skews and flanks, *the rest of the* roof being slated. In some cases,

however, when the sides, C, are pretty large, they are slated.

Fig. 153, again (which in some localities is known as the "storm" window), is quite the opposite to Fig. 152, this being as far recessed as the other is projected.

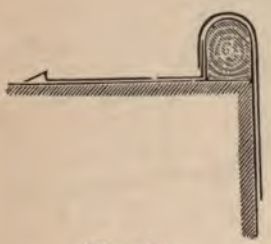


Fig. 154.

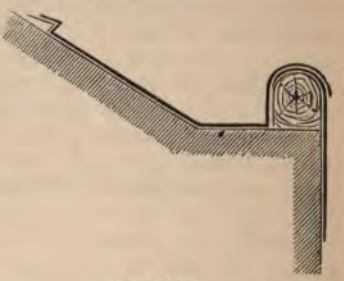


Fig. 155.

Fig. 154 shows how the flashings may be put in down the two sides; but Fig. 155 shows the better plan of overlap for the flashing, or rather gutter along the top of the window. The sides may be overlapped in a similar manner if thought desirable. The flat before the window is covered with zinc (of course lead may be used if wished), the two triangular sides of the window and the rest of the roof are slated.

Figs. 156 and 157.

Lead for domes is put on in something the same manner as described for flats in Chapter IX.—at least, so far as the rolls are concerned; but in cutting out the lead to fit its site great care must be taken to cut it out properly, or it may be cut too narrow; it will not do to cut it out as per Fig. 156, for that would make it useless for the *purpose, being* much too narrow in the middle; it must be *cut out in the* form of Fig. 157, and the swell made to

correspond with the circle of dome, and in cutting out the lead allowance must also be made, of course, for rolls.

When this article was being first published in April, 1872, I received from Messrs. Braby & Co.—through the

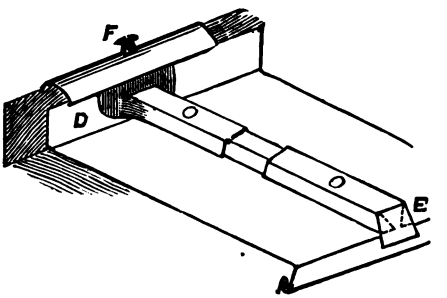


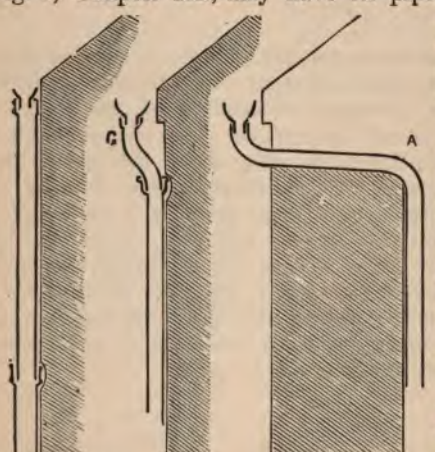

Fig. 158.

kind courtesy of their manager, Mr. Moore—a model of their late improvement in zinc roll-caps. This improvement, as shown in Fig. 158, consisted in bending up and working round the end of the roll-cap next the ridge without soldering it, as at D, and also in bending down the end of the roll-cap next the gutter or drip without any soldering, as at E, the bending down at E being done by "dog-earing" (see Fig. 54, p. 35) the corners inwardly, as shown by dotted lines at E. Their system of embossing the zinc upwardly at hole for screw, as at F, Fig. 158, is also good; it corresponds with that shown at Fig. 55, for lead apron. In using zinc care must be taken not to allow it to come in contact with lime, for lime *eats* it.

## CHAPTER XIV.

### RAIN-WATER PIPES.

THERE are various ways of conducting the rain water off the roof, and the rain-water pipes, "conductors," or "spouting," may be carried down either on the outside or the inside of the building. The common half-circle eave-gutter, Fig. 9, Chapter III., may have its pipe led down either, as per Figs. 160 or 161, on the outside of the building, or, as per Fig. 162, it may be carried through the wall and down the inside of the building. In this latter case a large raglet or recess is generally cut, or rather left, in the wall for it.



Figs. 160, 161, and 162.

When put in, as per Fig. 162, the rain-water pipe is often simply carried down far enough to join into the *top* of the water-closet soil-pipe, in which case it also serves as the ventilating-pipe for said soil-pipe; * but this plan is not so good as putting in a

* Using a rain-water pipe so does not serve the purpose so well for *top*, or outlet, ventilation as does a rain-pipe joining into a disconnecting trap for *foot* ventilation as shown, *e.g.*, in Fig. 411, while it allows *bad smells to blow in* below the slates.

separate ventilating-pipe *per se* for the soil-pipe, as during rain the mouth of the rain-water pipe may be bridged over by the water. The carrying up perpendicularly of a 3-in. pipe from A, Fig. 162, would help matters a little. The "offsets," or "S bends," G, Fig. 161, are of course of various sizes, to suit the place and style of roof.

In stone cornice-gutters the rain-water pipe is often dropped down right through the cornice, as per Fig. 163. At other times it is led away from the back of the gutter, as per Fig. 164, and may either go down just inside of the wall, or it may be led away between the ceiling joists right through to the gutter on the opposite side of the building, or it may go along horizontally to the centre of the house, and then join into some of the other waste-pipes. Or, again, it may be led into a large cistern, put up as a receptacle for the rain-water for the use of the house, as per Fig. 179, the overflow pipe of said cistern being disconnected from the drain as per Fig. 176.

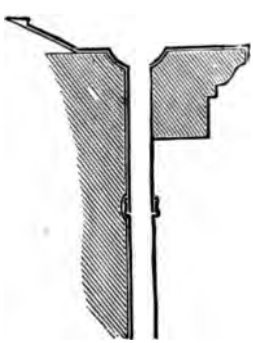


Fig. 163.

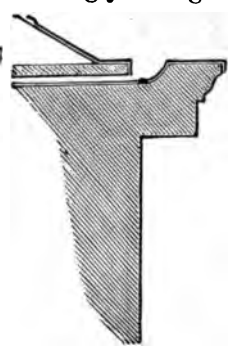


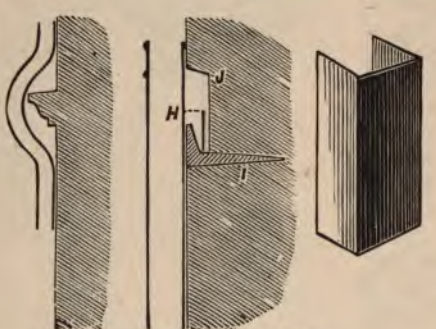
Fig. 164.

In many cases the architect objects to any rain-water pipes appearing on the front elevation of his building, and therefore makes provision for them coming down inside. In other cases, where the conductors are intended to come down in front of the building, and where they will have to come into contact with any string-course or other such mouldings, the architect shows his foresight by marking off a return with hole through it in the string-course for the pipe to go down through; and thus, when the conductor is put up, the string-course appears as if bent around it, which shows good planning. In other cases, where this is omitted and the string-course is cut through, it has never the same appearance; and then again to bend the pipe around the

string course, as per Fig. 165, appears to me to be a very clumsy job.

In the case of a projecting base, that of course is a different matter, as it is perfectly legitimate, especially where there is no traffic, for the descending pipe to be bent out and carried down the face of the base. Where there is traffic the pipe is often sunk into the base, so as to be flush with the face of the base. This pleases the eye better when the pipe is square than round. In some cases again the base is returned and the pipe carried down perpendicularly in line with wall front, and then brought out underground by a bend or "elbow."

Rain-water conductors * are made of lead, zinc, and cast-




Figs. 165, 166, and 167.

iron (in many country places both eave-gutters and pipes are often of wood, but that appertains to the joiner or carpenter), and they may be either round, square, or semi-circular. There are various ways of supporting them. The simplest way is by driving in iron holdfasts which clasp the pipe and press it close against the wall; but, except in the case of round iron pipes, these neither look nor hold so well as other systems of fastening.

The hook-and-eye fastening does well for either lead or zinc conductors. The eye, H, Fig. 166, is a piece of strong

* *The metal of all iron inside* rain-pipes should be ¼-inch thick, and *they should be painted* or coated both inside and outside, and locked *off from 'drains at foot* by a disconnecting drain trap, as e.g., by *Fig. 415 one, or they* may discharge above ground over an anti-bell *trap, Fig. 458. In this* connection see Figs. 176 and 177.

sheet copper, about one-tenth of an inch thick, and about 2 in. square, bent round, as per Fig. 167, and strongly soldered on each side to the back of the pipe. This copper eye comes down on the iron hook I, Fig. 166; I being driven firmly into the joint of the wall. In order to allow H to slip down over I, a small niche must be cut in the wall, as at J, Fig. 166, for that purpose.

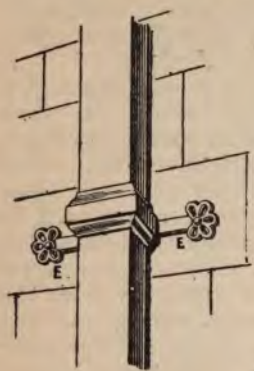
In tinning the copper, and in order to do it properly, it is best to file the surface with a sharp "bastard" file, which enables the solder to take a firm hold by riveting itself as it were among the channels left by the teeth of a file. When the copper eye is to be soldered on to a lead pipe, it is best to use rosin in tinning the copper. Some, from laziness, tin the copper without filing it, by using diluted spirits of salts (see Chapter X.), but this makes a bad job, the solder not holding properly; in fact, it often gives way from this cause. I may here mention that when tinning iron with diluted spirits of salts, a small strip of zinc is a good thing to use for putting "spirits" on with; using a piece of wood for that purpose has a bad effect.

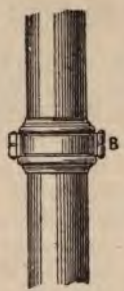
In using zinc-pipes, instead of making the eyes out of copper they may be made out of a piece of strong zinc. Sheet-brass may also be used; and in the case of lead-pipes, where neither copper nor brass can be had, a piece of good strong lead may often serve the purpose, only it must not be put on too narrow, for short eyes tear the pipe. In the case of zinc-pipes, one eye in each length may often do, and even in 3-in. lead-pipes one good eye in a 6-ft. length holds it for many years, but for a larger size of pipe, or all the better jobs, two eyes in the length will do best.

Another plan of supporting lead or zinc conductors is by means of bands put round and soldered to the pipes, which bands have iron flat-headed spikes driven through them and into the wall. The iron pipes are supported by iron bands, or "loose ears," as well as by attached ears; the latter are cast in one with the pipe.

Fig. 168 shows vertical sketch of a square iron pipe, and also of its cross section, in which the iron pipe is supported by a loose iron ear, E, held by two strong iron spikes, S, driven into the stone, or rather into two holes cut into the stone about 4 *in. deep,* into which holes, wooden dooks or plugs *have been driven* and cut off flush with the outer face of *the stone.*

Fig. 169 shows a round iron pipe, supported at the faucet by a hinged malleable iron band, with strong stud at its back, which is fixed into the wall by lead run in and bolted. An iron bolt put in at B fixes the outer half of the band and keeps the pipe in position.



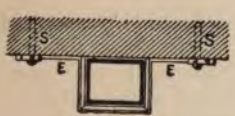




Fig. 168.

Fig. 169.

These ears and clasps are considered more artistic than the ordinary holdfast, Fig. 170.

It often happens that one main down-pipe has to receive one or more branch pipes. If these branch pipes are the same size as the main down-pipe then the branches cast on to main pipe require to have faucets, as per L L, Fig. 171; but if the branch pipes be smaller than the main pipe, then the branches cast on may do without faucets, as per M M, Fig. 172, only care must be taken in this latter case (say, by marking it) to see that the branch pipe is not slipped in too far, and thereby choking up the passage.

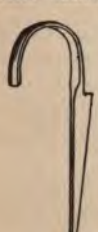


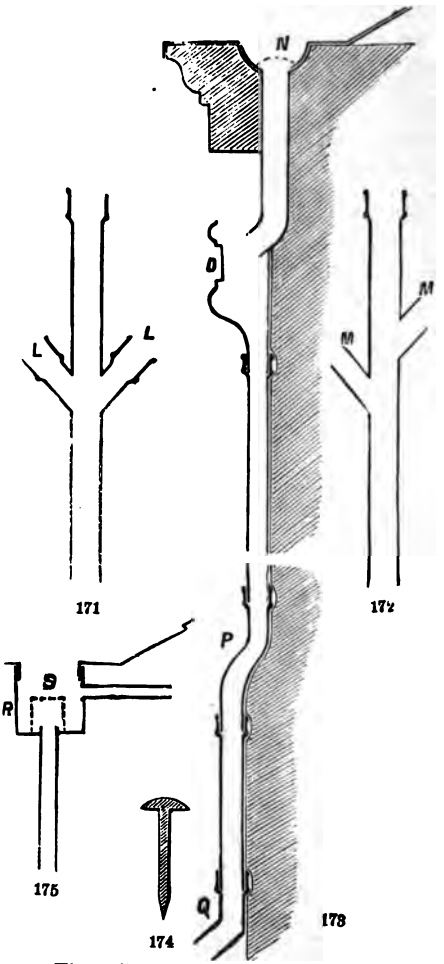
Fig. 170.

The branches with faucets cast on, as per L L, Fig. 171, may be had of various sizes—*e.g.*, supposing the perpendicular pipe, Fig. 171, were 4 in. in diameter, then the branches L L cast on might be made either 4 in., 3 in., or 2½ in. in diameter, or if the main pipe were 3 in., then the branches might be 2½ in., and so on.

These cast-iron pipes are generally made in *6-ft. lengths*, and of various diameters. The *round pipes vary from* 1½ in. up to 8 in. in diameter. The *square iron pipes* are made from 2½ in. by 2 in. up to 6 in. *by 6 in.* The *iron offsets* can also be cast to suit any slope

of plinth. The round pipe 3 in. in diameter is a size that is largely used in common house-work for the rain-water pipes, and as waste-pipes from the kitchen sinks. Fig. 173 shows conductor with rain-water head, carrying off water from gutter N; O being rain-water head, P offset at plinth, and Q, shoe at bottom to go into drain. In place of shoe Q many prefer a bend or elbow here, one reason being that it projects out farther. When it is necessary to cut one of these iron pipes, or to reduce its length, it may be done either by filing it round where it is wished to be cut, or else by chipping off the portion that is too long. Or, again, short pieces can be had from the foundry.

The iron spikes, Fig. 174, referred to above, are made from 3 in. to 5 in. long and from about ⅜ in. to ½ in.




Figs. 171, 172, 173, 174, and 175.

*thick. A great many designs for rain-water heads ar executed in iron, yet both lead and zinc heads are often us Iron, however, is largely superseding lead for this purp*

When the rain-water pipes are carried down inside the house and connected to drain, care must be taken that all the joints are properly and securely made. Upon jointing and fixing the pipes, however, we shall treat more at large as we go on to speak of soil-pipes and waste-pipes, &c.

Figs. 176 and 177 show two modes of disconnecting the rain-pipes from the drain so as not to allow any bad smell from the drain to get up them. In Fig. 176 the rain-pipe discharges above ground over an iron grating set in a

Fig. 176.

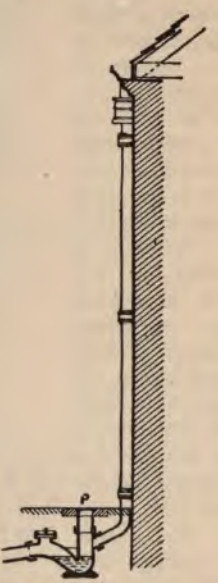



Fig. 177.

dished stove, or fireclay block, below which is the box or gully trap T. The grating in this case may also serve to carry off surface water.

Fig. 177 shows a 4-in. No. 2 Buchan's trap with the rain-pipe joining into it below the ground, the water-trap *locking off bad air from* the drain. Access to the house *side of the trap is got by lifting* the movable iron plate, P. *Where surface water* has not to be carried off I often prefer *his style to Fig. 176* plan.

In these two drawings the pipes are carried down the outside of the wall, but they may be carried down inside, and bent out through the wall at the bottom.

Another plan in use for leading away the water from the gutters is to have drip-boxes on the top of the rain-water pipes, as per R, Fig. 175. These drip-boxes are of various sizes, some may be 1 ft. deep and the same in length and width, others less, just as they may have to suit the place. A perforated grating, S, and an overflow pipe, T, ought to be put in for them. Perforated gratings ought also to be put in over the mouth of the pipe from other gutters, as per dotted line below N, Fig. 173. These perforated gratings

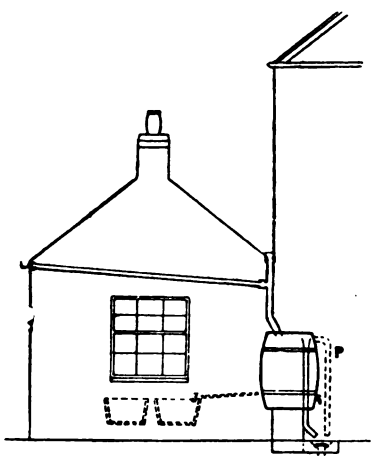



Fig 178.

are generally made out of pieces of lead or zinc with a number of round holes about $\frac{5}{8}$ in. in diameter either punched or bored through them.

Another style of "gratings" or pipe-mouth guards may be made by using *tinned* brass wire about $\frac{1}{8}$ in. thick, placed crosswise, and so as to leave square openings about $\frac{3}{4}$ in. or 1 in. wide according to the size of the pipe. These latter "gratings" do not get choked up so readily as the *former.*

*In many localities* where the water supply is either *scarce or the* water hard, the people catch all the rain-wa

they can either in one or more barrels set up outside of the house, as in Fig. 178, or in a large cistern placed under the roof, as in Fig. 179, or in a large underground tank built of bricks and cement and puddled with clay. When the rain-water is collected into an underground tank it has to be pumped up out of it into a cistern set up upon a higher level, from which cistern the water is drawn by gravitation in the usual way.

In Fig. 178 the water is indicated as being led from the barrel to supply two wash-tubs supposed to be placed in the wash-house. The overflow pipe of the barrel may either be placed inside the barrel (in which case it may be movable), or it may be fixed outside as per dotted line, P.

The first plan permits the water being run off at bottom for cleansing. The overflow water discharges over or into a dished basin with iron grating, having a disconnecting

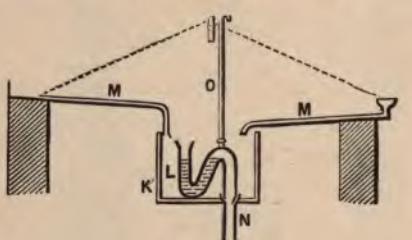



Fig. 179.

fireclay siphon-trap underneath (not an iron bell-trap) as per Fig. 458.

In Fig. 179 the overflow pipe, N, ought to discharge over a siphon-trap, and should not be led directly into the drain.

I add some interesting remarks by the late Dr. William Wallace, F.C.S., Glasgow, in regard to the action of water upon lead. He states that he has frequently seen lead pipes eaten through by contact with lime, and explains the phenomenon in this way:—Rain-water acts rapidly on lead under certain circumstances, because it contains free oxygen and no carbonic acid. When exposed to the air, however, *it rapidly absorbs* carbonic acid, which destroys or limits its *power of dissolving lead.* Rain-water in contact with, or *passed over, lime or mortar* (which requires many years to *become completely* carbonated) acts on lead with great

energy, because every trace of carbonic acid is removed from it.

On the other hand, it is well known that water highly charged with carbonic acid (as in aërated waters) dissolves an appreciable quantity of lead if passed through a leaden pipe. In the one case a small quantity of carbonic acid protects the metal by forming a film of carbonate upon its surface; in the other the carbonate of lead dissolves in the excess of carbonic acid. Water containing oxygen and free from carbonic acid dissolves lead much more rapidly than water highly charged with carbonic acid, and its action is usually limited to particular spots where wet lime or mortar is either in contact with the pipe or immediately above it. Dr. Wallace says he has seen a thick water-pipe eaten through in a few months.

A good coating of tar would tend to protect lead in the above circumstances, I believe.

## CHAPTER XV.

### Waste-Pipes and Soil-Pipes.

We now approach a branch of our subject which is closely connected with one of the great questions or problems of the day, to wit the sanitary question. The problem here to be solved is:—How can we retain the use of our conveniences, such as kitchen sinks, baths, fixed wash-hand-basins and water-closets, within our houses, and at the same time the health of the occupants not suffer?

In the following pages it shall be our endeavour to throw a little light upon this subject, and if what is said be in accordance with true sanitary laws or policy, we trust that architects, plumbers, and others interested will see that the work is *practically* carried out as suggested. If better plans are brought forward, very good, carry them out, only let "scamping" in this matter be everywhere denounced.

In many cases the waste or discharge-pipes from sinks, baths, &c., and the soil-pipes from water-closets, are either altogether fixed up inside the building, or, at least, have branches carried forward more or less into the interior; it is necessary, therefore, that they be fitted up in such a manner as, while allowing free passage to the soil, &c., to also prevent any foul air from them, or from the drains into which they are led, getting access to the interior of the house.

In order to work well it ought to be observed that the pipes are of the proper size, strong enough, firmly fixed, securely jointed, properly trapped, and well ventilated. To give soil-pipes* fair play they should be, at least, 4 in.

* Some plumbers and architects have of late been using soil-pipes of only 3 in. or 3½ in. diameter internally, and especially for only one *water-closet. The* 3½-in. pipe does pretty well, being well ventilated, *of course. At present* the Local Government Bye-Laws say 4 in. *diameter.*

in diameter internally.* This size of pipe allows of a large rush of water and soil through it without filling it up, and thereby helps to prevent said rush from interfering with the water lying in the various siphon traps. Where several water-closets and baths,† &c., are led into one soil-pipe, the diameter of main soil-pipe may sometimes be 4½ or 5 in. inside, the branches being less. Where the water-closets are situated just inside the back wall of the house a 4-in. inside cast-iron pipe is often put up on the outside of the wall with branches coming into it.

One plan sometimes adopted in regard to these branches is to have the branch pointing into the wall, as per U, Fig. 180, into which the branch pipe V is led; but this, although it may save a little pipe, often proves a dangerous plan for the health of the inmates, as when the slip-joint at U, Fig. 180, begins to get slack, or is, perhaps, left slack, and allows the foul air to get out, this foul air, unless the hole in the wall around V is solidly and securely built, finds its way along the outside of V into the house.

To prevent this, instead of making the hole for the branch pipe immediately behind the main soil-pipe, make it a little to one side, and put a bend on the branch pipe coming out through the wall, as per Fig. 181. In this latter case, although the slip-joint should be slack, it is outside the wall, and the hole in the wall at the bend, W, can be easily made good.

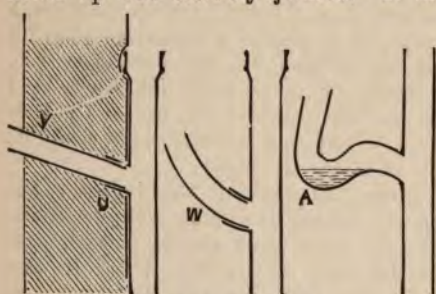
These remarks about Figs. 180 and 181 are also equally applicable to the waste-pipes of kitchen sinks, when these sinks are put up inside of flatted houses. In slipping in these branch pipes the plumber ought always to see that they are not slipped in too far. I have seen many instances in which this has been the case, and a chokage caused thereby. These slip joints outside may be made good with red-lead putty and hemp. Although a cheap way of doing the work, yet if fairly executed it does well enough, only do not neglect to ventilate the pipes properly. One disadvantage, however, of either soil-pipes or waste-pipes put up

* Especially if closets like the Bramah, letting off a large body of water quickly, are used. The size of the pipe must not be depended upon for protection against siphonage of the water traps, but air pipes off top of the outgo of the traps put in.

† It is not considered a good sanitary arrangement when the bath *waste is joined into* the closet soil-pipe.

outside the building, is their liability to being frozen up in frosty weather, and so preventing the proper use of the water-closets and sinks, &c., or, if they are used, causing the property to be flooded.* In such circumstances the branch being put in as per Fig. 181 is found to be often of great service, as by cutting a slit in the top of the portion of the lead bend W, Fig. 181, which is outside the wall, the water may be allowed to run off at this slit, and so prevent or lessen damage inside.

When soil-pipes and waste-pipes are put up *inside* the house, great care should be taken that they are properly fitted up and securely jointed. If the main upright pipe is of cast iron then it ought, for a good job, to be heavier and stronger than the ordinary iron rain-water pipe. The iron in the latter may only be about one-eighth of an inch thick, but about double that thickness, or more, ought to be used for the former. The vertical joints may be made with red-lead and hemp, or more firmly still by running in the joints with melted lead and then batting them.



Figs. 180, 181, and 183.

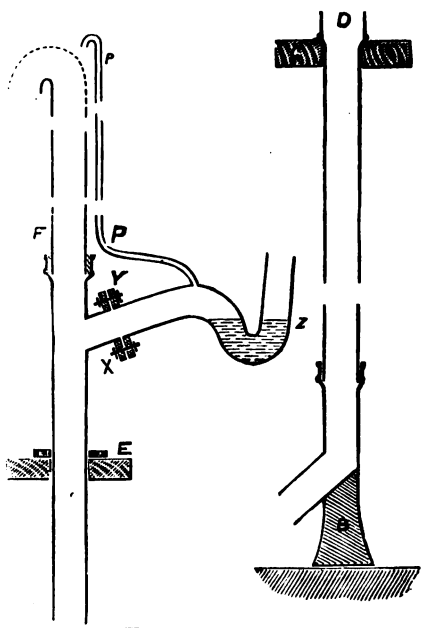
If any slip-joints are made where the lead branch pipe joins the iron, the joint should not only be made with red-lead and hemp packed in firmly, but it ought also to be either lapped or an india-rubber band 3 in. broad put over it, or, which is better, a brass ferrule used, with one end soldered to the lead pipe and the other end run in with lead into the socket or faucet.

Where hot water is used another plan is to have flanged iron branches, as per X, Fig. 182, a corresponding lead flange being made and soldered to the lead pipe, as per Y, Fig. 182, after which the two flanges are red leaded and packed, and then firmly bolted together with four iron bolts

* *It is seldom* the waste water put down that freezes, but the water *from some bad* or leaking crane running continually, which should *not be.*

and nuts, as shown, an iron ring or "washer" being used at the back of the lead flange to strengthen it.

In fitting up these heavy iron pipes, and, indeed, all soil-pipes and waste-pipes inside a house, it must be seen that, as stated above, they are *securely fixed.* When this is not done the fact of having them large enough, strong enough, properly trapped, and well-ventilated is, after the lapse of a little time, quite useless in preventing the escape of sewage gas into the house, as when the pipe is not securely fixed it by-and-by slips down, and the siphon-trap, instead of being properly locked, as shown at Z, Fig. 182, is dragged down at its outlet until it assumes the position shown at A, Fig. 183, and so becomes quite useless.




Figs. 182 and 184.

I have seen many examples of this, especially in connection with the siphon-traps of kitchen sinks. In order to prevent these heavy iron pipes from slipping down, a good plan is to have a strong iron heel cast on to and along with the lower length or "boot," as per B, Fig. 184, which heel must be set firmly upon a solidly-laid block of stone, so that there may be no chance of the iron pipe sinking.

If the pipe goes up against the wall it ought to be well holdfasted also; but if a raglet or recess has been left in the wall for it, or if it goes up in a corner, then, instead of the holdfast, a strong block of wood about 3 in. or 4 in. thick, *and about 18* in. or so long, and 10 in. or 12 in. broad,

as the case may be, with a round hole cut in it large enough to allow the pipe to be slipped down through it, should be got and set into space, and rest cut for it in the wall, as per C, Fig. 184, the pipe resting upon its faucet as shown. When, however, the length of iron pipe has flanged branch upon it, as per X, Fig. 182, then, instead of resting upon its faucet, as shown at D, Fig. 184, it is supported as shown at E, Fig. 182; a pair of strong malleable iron clamps, Fig. 185, being put on, and screwed up so as to grasp the pipe firmly, and at the same time be allowed to rest upon the wooden block.

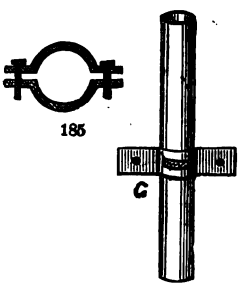
Instead of the wooden block a malleable iron plate about 1 in. thick or so, with a hole cut in its centre to fit the pipe, may be used. The length and breadth of this plate must, of course, be regulated according to its site. In many cases about 18 in. × 10 in. may do for a 4½-in. iron pipe, or with thicker plate less breadth will serve.

The slipped joints of these pipes, as at F, Fig. 182, may, as we have said above, be made with red-lead and hemp; or stronger still, by stuffing joint partly with hemp and then running in lead; some, again, make rust joints. Whatever plan is adopted, the great point is to see both that it is well done, and that it also thoroughly answers the purpose. These strong iron pipes have been largely used of late for the main upright soil-pipe in many houses, especially where hot water is used, and I consider it quite right to do so. As lead pipes, however, are still largely used, not only for the branches, but also for the main upright pipes, we must now refer to the way in which they are fitted up.

Lead soil-pipes should not be made of lead less than 6 lbs. per square foot at the very least, while 7 lb. lead, or heavier, is used for good work. These often require repairs and renewal from three causes: from being put up of too light lead at first, from being too slimly fixed up, and from corrosion, the latter being often in great measure owing to the want of proper ventilation. We cannot do with lead as with iron, for where, as in Fig. 184, the heeled boot B, if solidly fixed and not afterwards interfered with, may almost of itself be trusted to support a high superincumbent stalk of iron pipe above it, yet such could not be done with lead, the material being too soft; its own weight would crush it. To obviate this an upright lead soil-pipe must be well supported all up its entire length, every few

feet being supported, as it were, independently of the rest.

The old style used to be to cut out lead bands of the same weight of lead as the pipe, about 6 in. or 7 in. broad and about 20 in. or so long, and solder them on as per G, Fig. 186, these bands being put on every 3 ft. or so. In this case the pipes lie flat, or rather close against the wall. But when the pipe either goes up in the raglet left for it in the wall, or up a corner, then wooden blocks are used, as mentioned above for iron pipes. For lead pipes these wooden blocks are generally put in one at every 6 ft., or, better still, one every 4 ft. or so.



Figs. 185 and 186.

If the soil-pipes are hand-made they may be cut out in lengths from 6 ft. to 7 ft. 9 in., according to the breadth of the lead sheet. Or, as is sometimes done, they may be made in lengths about 12 ft. or 14 ft. long, to suit the height of the various flats in the house. In other cases seamless or machine-made pipes are used in lengths as got from lead-works. Fig. 187 gives an idea of a 4-in. lead soil-pipe as put up in the raglet left for it in the wall of a two-flatted house, with 3-in. or 4-in. ventilating-pipe, H, carried out through the roof.

According to the model bye-laws, the ventilating-pipe, H, should be of the same diameter as the soil-pipe. I I are the lead siphon-traps of two water-closets; J J J J the wooden blocks resting on the wall and supporting the lead soil-pipe; K is the board for the ventilating-pipe; L is a lead flange put on to the soil-pipe where it enters the drain; M is the 1½-in. or 2-in. lead pipe put in to carry off the water from the lead "safe," or tray placed underneath the trunk of the water-closet. It enters, as it ought to do, below the surface of the water in the trap. N is the same safe-pipe, put in as it ought *not* to be, above the surface of the water in the trap. It often proves a nuisance, and has to be altered when so done.

Another plan of putting in the safe-pipe is to let it have a small 1½ *in.* or 2-in. siphon-trap for itself joined on to the *outlet of the* water-closet trap at O. This latter plan is *intended to* provide for the safe carrying away of the wate

when the water-closet is choked up, only it must be remembered that, to prevent this small siphon trap from drying up, a small ¼-inch pipe must be led into it from the water-closet service-pipe, so that every time the water-closet is used a little water runs into the safe trap.* P is a small ventilating-pipe, from 1½ in. to 2 in. in diameter; it is put in here because it is found that even with the ventilating pipe, H, in on the top of the perpendicular soil-pipe, foul air or gas is apt to gather at Q, and in process of time it eats through the pipe there. *E.g.* I had an instance lately, one of many, where the action of the gas on the pipe appeared as if some one's finger had been thrust through the pipe from within. The people in the house complained of a very bad smell occurring at times, and this hole, eaten through the pipe at Q, was the cause of it. Instead of putting in this small ventilating-pipe as per P, Fig. 187, it may with advantage be put in as per P P, Fig. 182.

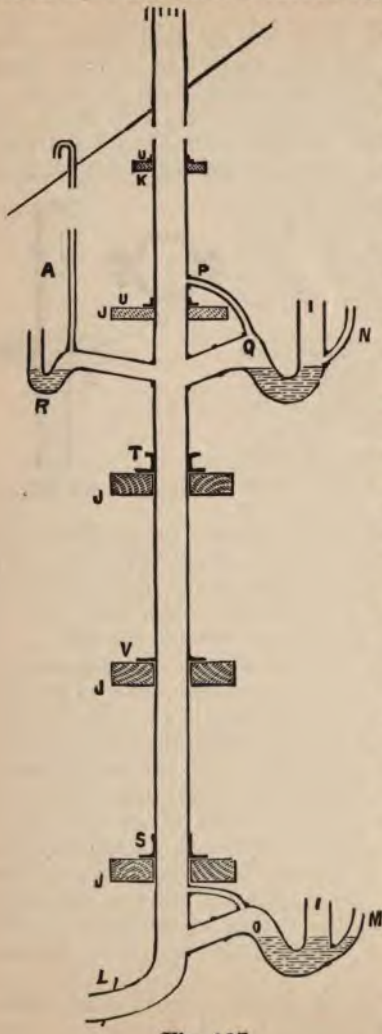



*Fig.* 187.

* *Instead of or with either* M *or* O, *a pipe may be led from safe through the outer wall with a hinged valve at its outlet, which many prefer.*

In the case of iron soil-pipes especially, instead of connecting the air-pipe from the branch soil-pipe—more particularly for the lower traps—into the main soil-pipe directly as in Fig. 187, a 2¼-in. or 2-in. air-pipe may be carried up from the lowest trap above all the traps and receiving into it the air-pipe from each trap as it passes, as shown in sketch here given Fig. 188.

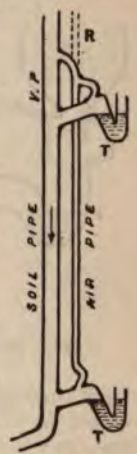


Fig. 188.

This is a better plan than that shown in Fig. 187. Where a bath, &c., at some considerable distance, discharges into the soil-pipe, as at R, Fig. 187, it is sometimes better to carry up the air-pipe, as per A, independently, instead of joining it into the soil-pipe. Insufficient or improperly ventilated soil and waste-pipes are often the causes of bad smells in houses, owing to the rush down of the water from one water-closet or bath sucking the water out of some of the other traps. Further information upon this subject will be found in connection with Figs. 417 and 461.

While the first edition of this treatise was being published, viz., in 1872, I was rather astonished to read the following statement in connection with the plumber's work of Sandringham House in a recent number * of such a largely-read and popular work as Cassell's "Technical Educator," viz. :—"Every soil-pipe should have a ventilating-pipe from its topmost point, communicating with the external air, of not less than two inches in diameter, and then the pipe itself becomes as it were the flue by which the remainder of the system with which it is connected is ventilated ; and in some cases this is so completely carried out, where unusual care is required, that the *space between the bottom of the valve and the water in an ordinary valve-closet has a small air-pipe running into the ventilating soil-pipes.* We may mention Sandringham House as an instance of the adoption of this precaution."

Now this plan here recommended—had it been really carried out—of leading the air-pipe from the water-closet *trunk into the* ventilating-pipe of the soil-pipe was anything

* *It was at page 272 of No. 99, vol. iii., which came out on March 7th, 1872.*

but a "precaution." I am happy to be able to state, however, upon the authority of the firm who executed the work, that the above description is a mistake, and should be a "2-in. lead air-pipe is taken from the outgo of the trap and branched into the main air or ventilating-pipe of the soil-pipe." This is similar to the pipe P, Fig. 187. Fig. 189 will enable non-practical readers to understand the mistake referred to. 1 is the level of top of water in siphon trap, 2 is the valve under the water-closet basin above referred to, while 3 is the "air-pipe running into the ventilating soil-pipe" from the space between the bottom of the valve and the surface of the water in the trap.

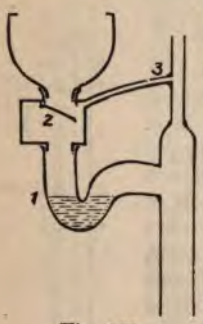


Fig. 189.

Now it will be at once seen that if the valve were open, or if any opening existed about the valve journal (as is often the case), said opening, &c., would allow the sewage gas from the soil-pipe to come back through this air-pipe "3," and so poison the air of the closet in which the water-closet is situated, and in such a case any person coming into this closet, say, before breakfast, and with an empty stomach, might carry off the seeds of typhoid, diphtheria, or other fever with him, especially if the soil-pipe were untrapped at its foot and insufficiently ventilated. The description, however, was an unfortunate mistake, and since I first called attention to it I understand that the publishers of "The Technical Educator" have taken means to rectify the error.

It is quite correct to put in an air-pipe (I have often put in two) between the water in the trap and the valve or pan above it, but it should not be run into the ventilating soil-pipe, but be carried out to the fresh air outside. By this *latter* plan not only will the space between the water in the trap and the bottom of the valve be kept purer and ventilated, but if any back draught does take place it will be a current of fresh air, not one of bad gas from the drain, as in Fig. 189.

Owing to what I had read and the remarks published thereanent by me in the *Building News* for May 17th, 1872, *I wrote to* His Royal Highness the Prince of Wales, regard*ing the occasion of his* illness; he very kindly replied, stat-

ing that he was quite unaware in what manner he had caught his typhoid fever.

Before closing this article upon lead soil-pipes, attention may be drawn to the different styles of soldered joints referred to at Fig. 187, and drawn to a larger scale at Fig. 190. S, Fig. 190, is section of a "round joint," made about 6 in. or so above the board, the pipe being supported by the wiped soldering, $S^a$, connecting it to the lead flange which rests on the board. T is "flanged joint," with lead flange 6 in. or so below it supporting the pipe. U U, Fig. 187, and U, Fig. 190, are "flange joints," with the tops of the lead pipes flanged back on the boards, the top edges of the boards being rounded off and countersunk so as not to cut the lead where flanged back. This style at U is simpler than that at S and $S^a$, and T, as it saves a soldering, but many plumbers consider that it does not make so good a job. V is simply a lead flange about 8 in. or 9 in. in diameter over all, with wiped soldering attaching it to the pipe, and so supporting the pipe.

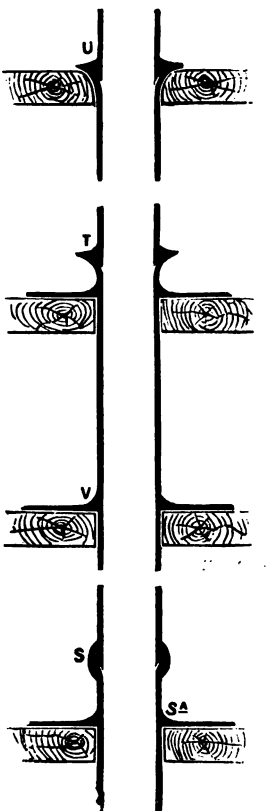
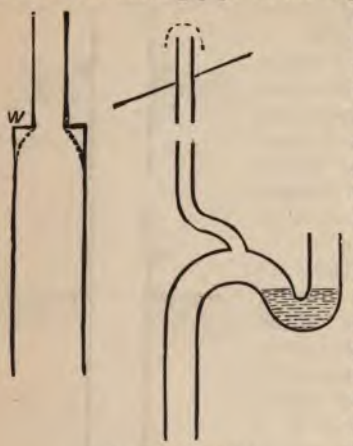


Fig. 190.

In the case of lead soil-pipes laid horizontally, they may be supported by being allowed to rest on boards. In some cases lead bands, as per Fig. 186, only differently fixed, are used. When I say "horizontally" I do not mean exactly level, for soil-pipes should always get as much of an incline or "run" as possible. In some cases, where the presence of rats may be feared, a piece of thin sheet zinc put round the lead pipe is a good protection against their teeth, but the best plan is to keep them out of the house altogether by seeing that the drains are *laid properly*, of which more anon.

Before leaving the subject of the fitting-up of soil-pipes, I would yet make some further remarks, and point out a few precautions necessary to be observed. In connecting (say) a 3-in. ventilating pipe to the top of a 4-in. lead soil-pipe, or a 3½-in. pipe to the top of a 5 in., it must be a rule always to contract the top of the soil-pipe, as shown by dotted lines Fig. 191, and not to do it in the style I have sometimes seen, and as shown by Fig. 191, where the top of the soil-pipe, instead of being gradually contracted as per dotted line—so as to leave no resting-place for the foul air rising up—is cut square across, and a flat disc put on with hole through it, as per W, Fig. 191, in which latter case this flat disc, as I have seen, gets corroded by the foul air and full of holes. When the ventilating-pipe is finished off at the top with a bend, as per Fig. 182, it is a good plan to bore several ½-in. or ¾-in. holes through the top of the bend.



Figs. 191 and 192.

Another style of finish is that shown by Fig. 192, but with the air-pipe larger, where the cup may also be perforated. Another plan is to leave the pipe standing up perpendicularly, and to solder on several pieces of tinned copper or brass wire across its mouth, as at H, Fig. 187. Of late, however, the placing of a ventilator upon the top of the soil-pipe, as in Fig. 417, has been highly approved of and largely in use. The best form is the fixed ventilator, specimens of which will be seen farther on.* See page 329.

Fig. 193 shows approved method of connecting the branch lead pipes or traps to a vertical iron soil or waste-pipe. In

* It should be mentioned that especially where the soil-pipe is used to ventilate the drain, and where more closets than one discharge into it, the soil-pipe should *not* be contracted at its top. For a soil-pipe *of one closet, with disconnecting trap at foot of the soil-pipe*, a 3-in. *ventilating pipe often* does very well.

this case strong brass ferrules, as at B and C, are soldered to the lead trap or pipe as at S, S, the other end of the ferrule being slipped into the faucit of the iron pipe F, and fixed securely with hemp and lead run in and staved up.*

A word now about the amount of "seal" or water-lock which the various lead siphon-traps inside a house should have. In my opinion about 1½ in. or 2 in. of "seal" is little enough; that is to say, that the depth of water lying, *e.g.*, in a 4-in. water-closet syphon-trap, should be about 6 in. or 6½ in. A good "seal" or deep water-lock should be especially given to the siphon traps in houses or mansions where the inmates are often from home for months together. For baths, wash-hand basins, &c., &c., no harm, but good, would be done by making the "seal" 6 in. or 7 in., or even more. To make it only ½ in. or rather less, as is often done, is simply a bad job, and is frequently the cause of those intermittent bad smells which are sometimes so difficult to trace out properly and to the satisfaction of all concerned.

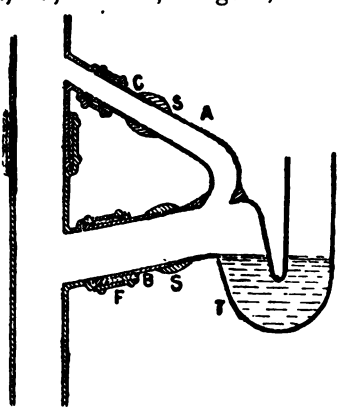


Fig. 193.

A great deal has lately been said about keeping back the foul gas of common sewer from getting into the house drains, which is very well, but this is not all, for it must be remembered that foul air gathers in the house drains and pipes themselves, independently altogether of the common sewer.†

In order to prevent this foul air getting exit into the house, all the joints of the drains and pipes must be properly and securely made; and, as above stated, all the siphon traps must have sufficient seal; and lastly, to pre

* More especially when the brass ferrules are not tinned inside, the lead pipe—full bore—should be passed quite through the inside of the brass ferrule as a protection to the brass from acids.

† Various persons have written as if they ignored this fact; nevertheless, so far as I can judge, disease has often arisen from the house *drains and pipes*, independently of the common sewer.

vent its concentration this foul air must be allowed exit either at the ventilating-pipe of the soil-pipe, or waste-pipes, or in some cases when away from a window and provision is made to prevent it going in under the slates, a rain-water pipe may be used, or as I have often done since 1875, a special outlet ventilating-pipe may be put up for the house drain itself, while the soil and waste-pipes are individually trapped and ventilated.

Fig. 193A.

Fig. 193A shows how a lead soil-pipe that was inefficiently and in part non-ventilated was corroded and holed.

Where the pressure of gas coming back from the main sewer is supposed to be occasionally great, it may be carried off and kept out of the house drains by putting in a ventilating pipe to the top of the roof from the outer eye of the disconnecting siphon-trap which divides the house drain proper from the outer drain leading down to the common sewer, as shown farther on in Figs. 417 and 461.

Supposing the drains and soil-pipes were put in properly and, so far as they are concerned, *per se*, all right, yet there are other things still to be attended to which must be done *correctly* or evil will ensue, and to come to them we must *now refer to water-closets*, cisterns, and their fittings.

## CHAPTER XVI.

### WATER-CLOSETS.

WHEN the author was attending, as one of the delegates from Glasgow, the third annual Congress of the District Councils of Scotland, held at Dundee in September, 1892, in connection with the Registration of Plumbers movement, he was invited, when St. Andrews was then visited, to see "the oldest extant water-closet in Scotland," stated to be situated in the old Bishop's Castle there, now only an interesting old ruin, and in some respects especially so to plumbers. See Fig. 194.

The closet is built projecting out beyond the line of the wall 18 in., with a flat stone for seat 22 in. × 18 in., with large hole in centre. This stone appears to have been covered with wood, and no doubt the opening had a moveable lid to keep out the wind. The size of the closet apartment inside is 4 ft. 8 in. from door to front of seat, and 2 ft. 6 in. wide. Height from floor to ceiling 6 ft. It had a window. The drop outside from closet to high-water mark is about 50 ft. The only provision for flushing the wall of the building outside and the rocks I could see was the rain and the sea. In the other corner will be seen what appears to be the stone gutter for a sink. The waste water here had a fall of 40 ft. to reach the German Ocean below at high-water mark.*

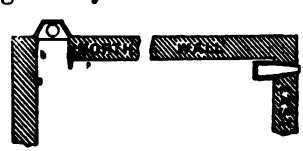


Fig. 194.

* "Aye," says the Archbishop's ghost, as I write—dead as a red herring though he be—"we thocht oursels nae sma'beer in those days, when we were sae weel provided for in the sanitary way. Did ye no publish yoursel' in 1869, that on the 27th day o' August, 1548, the Bailzees and Counsale o' Aberdeen had to send to Sanct Andrewes *for ane plumber to* reforme and mend the faltis of their kirk?"

In buildings abutting on, or overhanging, the sea, direct discharge into the salt water from sanitary appliances would be quite natural, although without pipes the sanitary condition or artistic appearance of the walls or rocks would not be improved, especially when the waste water had a great distance to fall. Water-closets with a supply of water let on to them by means of pipes seem to have been fitted up by the Roman engineers about two thousand years ago.

Through the kindness of Mr. Turpie, R.P., I have received a still older reference to St. Andrews' plumbers from Mr. David Henry, architect, there. This is an "endentur," or agreement between John, Abbot of Aberbrothoc, and a St. Andrews' plumber, in A.D. 1394, to "theke the mekil quer wyth lede, and guttyr yt al about sufficiandly wyth lede, for the quhilkis thekyn and gutteryn the abbot sal pay him xxxv marcis at syndry termys, as he is wyrkand," &c. When he is finished with the work he is also to get "a gown with a hude till his rauarde." In his "Principles and Practice of Plumbing" Mr. S. S. Hellyer has an interesting chapter on the History of Water-closets.

After the downfall of the Roman Empire sanitation in Europe, except by the Moors in Spain, was very much ignored. The dark ages revelled in filth, moral as well as physical. Ignorance and superstition usurping the throne of the human intellect, while plagues and epidemics were the order of the day. Dirt was glorified. The more parasitical life about the person being considered by some a virtue! The mere thought, again, of the old "Gare l'eau" cries of Paris and Edinburgh should make us thankful we were not living when they were in vogue.

In some respects nineteenth-century "improvements," even where making the streets cleaner, left the atmosphere of the interior of many houses anything but healthier. The enormous cesspools dug in the cellars, or lower plots, of some houses, as recent examinations have shown, were often the causes of disease and death to the inmates, and especially in the mansions of the rich; the "out of sight, out of mind" policy of dealing with sanitary matters not being either the safest or the best.

Humanity has often been slow to learn, or, at all events, to get on to the right track. Greater progress has been made, *however, in* the last twenty years in this relation than in *about as many prior* centuries. Among the many blessings

bestowed upon humanity by our nineteenth-century prophets improved sanitation will not rank the least.

The conveyance from our houses of the fæcal products of the inmates in the least objectionable way, and on the safest plan, naturally leads us, and especially as plumbers, to the consideration of water-closets.

One of the simplest forms of water-closet is that known as the cottage closet, Fig. 195, supplied by a valve-cock with lever, handle, and weight, the water running only while the lever is held up. As will be seen in the sketch, this closet consists of an earthenware basin B, set upon a tapered lead socket S, which socket or seat rests upon a short piece of 4½-in. or 4-in. lead soil-pipe P, to which it is soldered. Underneath the short pipe P and below the floor is seen the lead trap T. Sometimes the lead trap is placed above the floor, as shown by Fig. 196. In this case the lead trap may be supported at S by a small wooden stool with a 4½ in. hole in its centre.

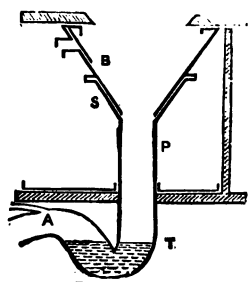


Fig. 195.

The great fault of this cottage closet is that no water lies in the basin; but if immediately before it is used a little water is run to wet the basin, and after use it is well flushed, then this closet often does pretty well.

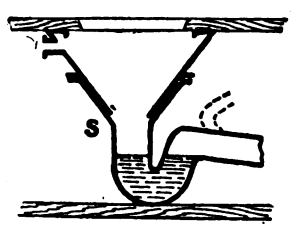


Fig. 196.

In some cases common ground or screw-down stop-cocks were put on for this closet, but they often caused great waste of water by being left running, one closet crane thus left open in the lower flat preventing the water rising to the higher flats in the property until it was shut. This leaving of the water-closet cocks open and propping up of the handles has caused the officials in many towns to pass a law that all water-closets must be fitted up with self-closing valves, so that only three gallons or so may be got at one flush. Some authorities only allow two gallons for each flush, but that is too little, although two

gallons of water properly delivered will often flush far better than four gallons badly delivered. There is no good reason, however, for delivering the four gallons badly.

The basin in Fig. 195 is a common round or oval basin, the same as used for the pan water-closet. The fan or water-spreader inside of the water-inlet of the basin is made out of a piece of 5lb. sheet lead, and is secured by means of two brass bolts and nuts. By this means the fan can be easily regulated, so as to suit the pressure of the water in each particular case; for this latter reason water-closet basins with lead or metal fans are often preferable to basins with earthenware fans.

In place of using a basin and lead tapered seat for their cottage closet, as shown in Fig. 195, some, for cheapness, used instead a long tapered, or "hopper" basin, as shown in Fig. 197. This hopper basin is much more difficult to keep clean than the one in Fig. 195, on account of the much greater surface exposed to the *excreta*, and the greater difficulty of getting the rush of water to spread over and cleanse the whole surface of the basin properly. For these reasons they are not to be approved of, and are now generally condemned.

Fig. 197.

Another form of water-closet is the well-known pan-closet, introduced about the end of last century, which formerly might either be supplied by means of a crane or a valve in the cistern above it This cistern was generally put up as per Fig. 198, and in many cases not only served for the supply of the water-closet, but also for all the water required for culinary and drinking purposes. This latter plan was not to be commended, however, as the water often suffered from contamination. The overflow-pipe of this and other cisterns has been a fruitful cause of bad smells, and the escape of sewage gas within houses. It has actually in some *cases* been put up as per Y, Fig. 198, with communication *to the soil-pipe quite open!*

*In thousands of other* cases it was just about as bad by *having a small useless* bell-trap put in at Y only a couple of *inches deep, and holding* but a few teaspoonfuls of water,

and which being hand-filled by the plumber, soon got empty by evaporation, when the foul air from the soil-pipe came blowing out quite freely. In this latter case, when a bad smell was complained of, the plumber often came, and finding his little bell-trap empty, he simply refilled it, and, of course, stopped the smell; but it was only for a few days or weeks, for it soon emptied again. The proper remedy in this case was to cut out the small hand-filled bell-trap and either put in a self-acting one, or what is better, and has been often done of late years, to disconnect the overflow-pipe from the soil-pipe, and either make it discharge into the open air, or else over the bath or water-closet inside, so that waste of the water from the ball-crane leaking may be at once seen and stopped.

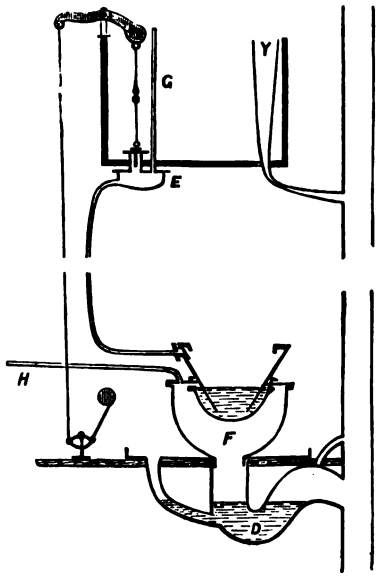


Fig. 198.

Fig. 199 is sketch of the small hand-filled bell-trap condemned above. Fig. 200 is vertical section of a self-filling bell-trap, made of either lead or sheet block tin. The outer case is about 9 in. deep, and about 3½ in. diameter. The middle pipe, which is fixed to the metal disc on top, is 2⅝ in. diameter and nearly 8 in. deep. The centre pipe is 1½ in. diameter. At A, one inch from the top, the outside pipe is all perforated round with holes ¼ in. in diameter. At B, 7 in. from top, there are three small holes ⅛ in. in diameter, while C is the height to which the water rises in the cistern. By this means both *waste* of water is prevented (unless, indeed, when *ball-crane leaks*) and air currents fresh or foul stopped. I do not *introduced this* style of trap about A.D. 1863.

Fig. 199.

recommend its use for cisterns, the water of which is used for drinking, unless in those cases where the overflow-pipe of the cistern is led out to the roof, &c., and has no connection with the soil-pipe or drains.

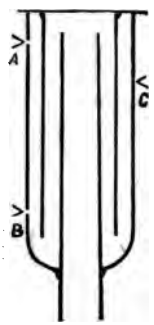


Fig. 200.

Where the overflow-pipe is carried outside of the house and no danger of bad smell need be feared, yet it is often useful to put on such a bell-trap as Fig. 200, in order to prevent cold air draughts, which in summer carry in dust, and in winter help to freeze the pipes. Against such this self-filling bell-trap is a better protective than the hinged valve put on upon the outer end of the overflow-pipe.

Another style of fitting in the overflow-pipe of the cistern was to carry it down to the siphon-trap of the water-closet, and join it at D, Fig. 198, a couple of inches or more below the top of the water. So long as there existed plenty of water in the closet-trap this style of connection was much safer than the shallow bell-trap, but it allows waste of water from the ball-cock, if leaking, to go on unseen, and it is better when the overflow-pipe is entirely disconnected from the soil-pipe.

In Fig. 198 E is the "service-box" which fills copper pan F with water when the handle is put down; G is the air-pipe of the service-box; H is a small ventilating pipe sometimes put into the iron cover, or top of the water-closet trunk, and carried to *the outer air* for the purpose of carrying off any bad air or foul gas which may gather between the pan and the surface of the water in the siphon-trap. This pipe H may be either a 1-in. or ¾-in. lead pipe. If the latter size, a piece of ¾-in. lead pipe 5 lbs. or 6 lbs. per yard will do very well. It is connected to the iron cover of the trunk by means of a brass coupling and brass screw ferrule with a brass jam nut. This ventilation of the trunk is important, and no pan, valve, or Bramah water-closet is complete without it. For proper ventilation, however, *two* pipes, an inlet and an outlet, are required. See Fig. 408.

*The pan closet*, Fig. 201, although largely in use still, is *generally condemned* by sanitary engineers as an unsanitary *appliance. Its* large cast-iron trunk or container C, in which *the copper pan* works, when it gets dirty becomes a veritable *manufactory* of sewage gases.

Another style of water-closet is that where the cistern and water-closet are all in one, as per Fig, 202, which shows a modern example patented about a quarter of a century since by Mr. Shanks. This closet was at one time very popular, but is now condemned as unsanitary, as foul matter from the basin can get access to the out-of-sight cistern or side water receptacle in which the ball-crane works. About fifty years ago this style of closet, with a three-tailed metal valve at its outlet, was styled the cheese closet, from the resemblance the side water receptacle had to the half of a large cheese.

Fig. 201.

In Fig. 202 the round indiarubber ball J, which forms the valve, is weighted by a piece of iron pipe above it and is worked or lifted by the handle I. K is the cistern, L is the copper ball of the ball crane, showing the position of the ball when the ball-crane is shut, and as will be seen the height of the water in the cistern K and in the closet basin is the same. When the handle I is lifted, and the water let off, the ball L falls and the ball-crane opens and lets the water flow into the basin to flush it. When the handle I is put down the valve J falls on its seat and the water rises in the basin and side receptacle K to the regulated height. The height being regulated to a little below the *overflow.*

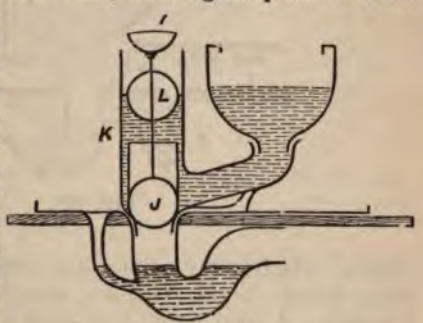


Fig. 202.

*In the case of slops* being put into a closet of this style *when the water is off,* it can easily be understood how dirty

and bad smelling the out-of-sight side receptacle K might become.

Mr. George Jennings, of London, had a "patent valve closet and trap," all in one piece of earthenware. The whole of it, trap included, is above and rests upon the floor, except the short nozzle at the outlet which enters the soil-pipe.

This closet is upon somewhat the same principle as Fig. 202, but in my opinion all the closets with side cistern out of sight and communicating with the water in the closet basin, and being upon the same level with it, are liable to become dirty and unsanitary appliances, as, although clean for a time, yet by-and-by foulness gathers in the out-of-sight division, and so may give off not only bad smell but also disease germs. Such closets, therefore, although serviceable for temporary uses on buildings, as at exhibitions, are not, as it seems to me, to be commended for fixtures in houses where the same closet is intended to be used for years. They are, however, probably superior to the so-called "trapless

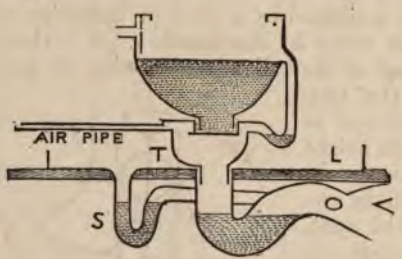



Fig. 203.

closets," which in my opinion are unsanitary *traps*, liable to cause disease in the dwelling, especially if not carefully watched. A good water trap upon a closet is like a good lock upon a door, a useful protective against robbers, and health robbers are really far worse than property robbers.

*The best of the* machinery closets is the "Bramah," or *par excellence* valve-closet, Fig. 203; its trunk or valve-container T *is much smaller* than the trunk of the pan-closet, *and its basin being* differently shaped, holds much more water

than the basin of the pan-closet, and consequently gives a better wash to the siphon-trap and the soil pipe. The Bramah is more expensive than the pan-closet, but it is a much more sanitary appliance.* See also Fig. 408.

The Bramah, like the pan-closet, may also be fitted up either with a crane or with valve in cistern and service-box; I must say, however, that for both I prefer the service-box and valve in cistern, as shown by Fig. 198. For a good job, the service-box of a Bramah closet should be larger than that for the pan-closet. The valve in cistern which fills the service-box should also be larger for the Bramah. The soil

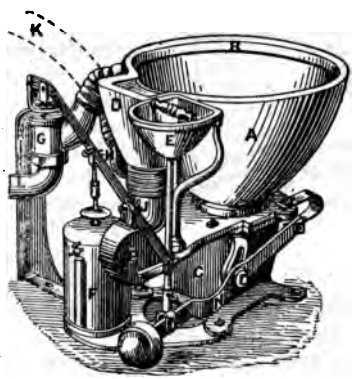



Fig. 204.

pipe should also be specially well ventilated for the Bramah. The use of the jet fan to flush the valve and help to send down the paper better would improve the Bramah.

As a preventive against the gradual accumulation of bad air or sewage gas between the water in the trap and the valve of basin, two air-pipes may be put in from off the trunk, as shown in Fig. 203. These air-pipes must in all cases be carried out to the outer air as already stated. For a gentleman's house, or for any one who chooses to pay for

* In Fig. 203 a 2-in. lead trap, s, is shown, for the safe or lead tray, L, said trap being kept filled with water by a weeping pipe from the *water-supply pipe* to the basin; but now the safe pipe is often led out *through the outer wall*, as shown at s, Fig. 205. In Fig. 203 the *larger trap*, as drawn, has too little water-lock.

it, I consider a good Bramah closet, properly fitted up, to be one of the best machinery closets extant.

Fig. 204 shows the "Optimus" or best style of Bramah closet, manufactured by Mr. S. S. Hellyer, of 21, Newcastle Street, Strand, London. The basin A has a novel style of vertical overflow D. K is an air-pipe for the trunk or valve-box chamber C. The water supply is let on through the lever crane or valve G, which has a bellows regulator F to prevent the crane or valve shutting, although the handle at E is put down until a sufficient quantity of water has flowed into the basin to flush and fill it. The size of the crane G and coupling L may be either 1 in., 1¼ in., or 1½ in. according to the pressure of water.

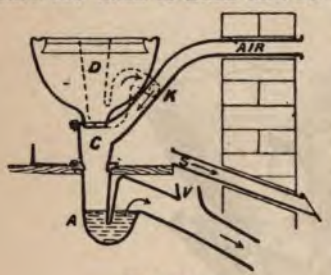


Fig. 205.

Fig. 205 gives a vertical section of the Optimus closet in which the overflow D of the basin is shown as led into the air pipe at K of the valve chamber C. S is the safety pipe from the lead tray, it has a hinged valve on its lower or outer end. V is the ventilating pipe of the branch soil-pipe hardly seen. A is one of Hellyer's anti-D-traps.

One of the most foolish crazes in connection with the fitting-up of water-closets, in my opinion, is fitting them up without a trap, as in Fig. 206. In this case should the water be off, and a piece of paper get in below the valve and keep it partly open, then foul air from the soil pipe may blow freely into the house for an indefinite period. No person of good common sense would have a closet so fitted in his or her house.

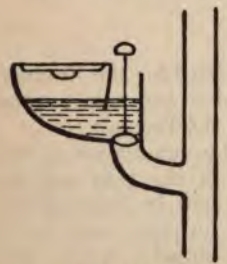


Fig. 206.

We come now to the more modern style of closets—without either machinery, pans, or valves in them—*which are largely* used of late years. The pioneer of these, on *what is known as the* "wash-out" principle, was, I believe, *the late Mr. Jennings*, of London; who, in August, 1852, *patented what was* termed the "Monkey" closet, of which

a vertical section is given in Fig. 207.* From this "Monkey" whole hosts of *homo* closets † have been evolved with some slight difference in detail, as shown in Woodward's Fig. 208, Bostel's Fig. 209, and others of later date.

A demand having sprung up a few years ago for exposed water-closets—for which Mr. John Honeyman, F.R.I.B.A., was among the earliest advocates—in preference to lined-in ones, various firms set themselves to make the wash-out closets more ornamental.

Fig. 210 shows one of these known as Twyford's "Unitas."

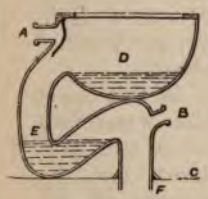



Fig. 207.

Fig. 208.

Fig. 209.

In this case, as will be seen, the wooden seat is hinged so that the closet may also serve as a urinal. Many firms make these closets in various styles of ornamentation all over the kingdom.

They work best when supplied from a cistern overhead. In some localities all the water-closets must be supplied from an overhead cistern.

In many cases with the wash-out closet the short vertical duct between the water in the basin and the water in the trap gets foul from urine, &c., not properly flushed away, and a bad smell gets up. In that case this duct and the basin should be brushed and washed with a round-headed brush, as per Fig. 211. This brush is a useful adjunct to all water-closets.

As part of the closet on the house side of the water trap in the wash-*out* closet is out of sight somewhat as at E, Figs. 207 and 209, this objection, with what has been said above, tended to lead to the introduction of, and in many cases

* *The ventilating* horn, B, is an addition of more recent years.
† *Mr. Jennings* must have been an active Darwinian.

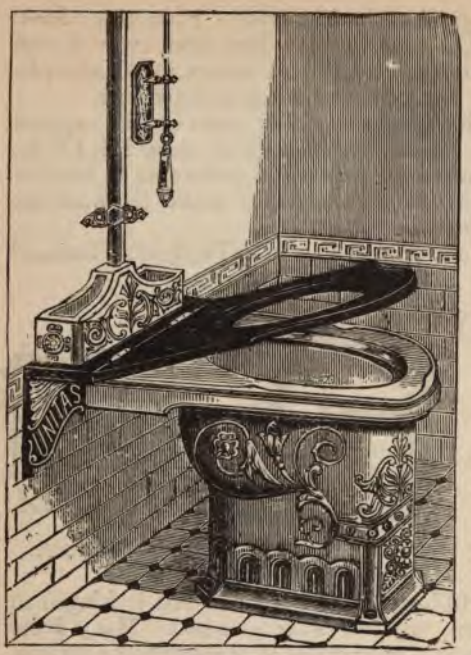



Fig. 210.

to the preference for, the wash-*down* closet in which the house side of the water in the water trap is seen right in the middle of the closet basin, as shown in Fig. 212, which gives a sketch in vertical section of Mr. S. S. Hellyer's "Vortex" closet.

In this closet the water-flush is in two portions, one, by means of the hollow rim R allows the water to flow round and flush down the inside surface of the basin, while a water jet J issuing from a hole in front of the earthenware rim falling on the surface of the water at W helps to submerge and send off the paper, &c. The "Carmichael" wash-down closet* is another modification on the same principle introduced by the author in 1879.

In Fig. 213 it is drawn in vertical section in one piece with P trap. In this case an adjustable metal fan is used for the water flush with a short jet pipe I in its centre. By means of this metal fan the water is made to flush round both sides of the basin † until it meets opposite the fan, and

* It was registered as the "Carmichael Wash-down Accessible Closet." The lid, K, permits access to the outer side of the trap by unscrewing two brass bolts.

† *In fixing* the metal fan, it should be made to press closely at its *bottom to the basin*, or else the water would run to waste there, and *have no proper force left to* flush round basin and also supply the jet.

forms a cascade, while at the same time a strong jet of water (as indicated by the arrow and "jet" in the drawing) submerges and sends off the paper and sewage.

Fig. 214 shows the "Carmichael" wash-down closet made in two pieces. In this drawing of it the trap is shown as an S-trap. The closet may be had in four different styles, as ordered, viz., Nos. 1001 and 1003 in the S-trap style, and Nos. 1002 and 1004 in the P-trap style. Nos. 1001 and 1002 are each in one piece of earthenware, Nos. 1003 and 1004 in two pieces of earthenware. The latter style allows the basin considerable freedom to be turned round in the direction most suitable for the service or flushing pipe; but on account of the joint—which, however, is above the water, as seen in Fig. 214—many prefer the closet in one piece.

Fig. 211.

Fig. 212.

Fig. 213.

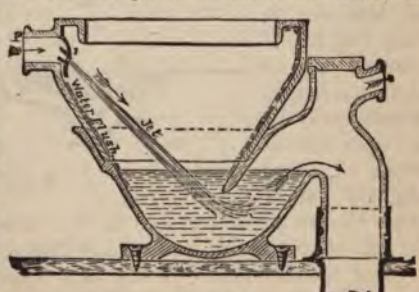



Fig. 214.

In many cases, as being more handy to use, I have a liking for the style in two pieces, and have it fitted up in my own house, for, when the basin and trap are well joined with either red lead putty, stucco, or cement, the two are virtually one. Then, again, if basin or trap gets broken of either *Nos. 1003* or 1004, only a half-closet is needed to put

things right, whereas if either Nos. 1001 or 1002 are broken, a whole closet would be needed.

In setting the basin of either No. 1003 or 1004 the inlet-horn of the basin should not be placed right above or over the outlet of the trap, but somewhere opposite to it, as in Fig. 214, or to one side (either right or left), as at C in Fig. 215. Attention to this in setting allows the water-jet to submerge and send off the paper, &c., better. This closet is supplied best, I think, from a cistern overhead, and with a 2½-in. or 2-in. valve and 2-in., 1½ in., or 1-in. vertical down-pipe according to height of the cistern. The pipe next the valve should not be less than 2 in. diameter, and should have a very small air-pipe, ½-in. diameter enough, and *no service-box.*

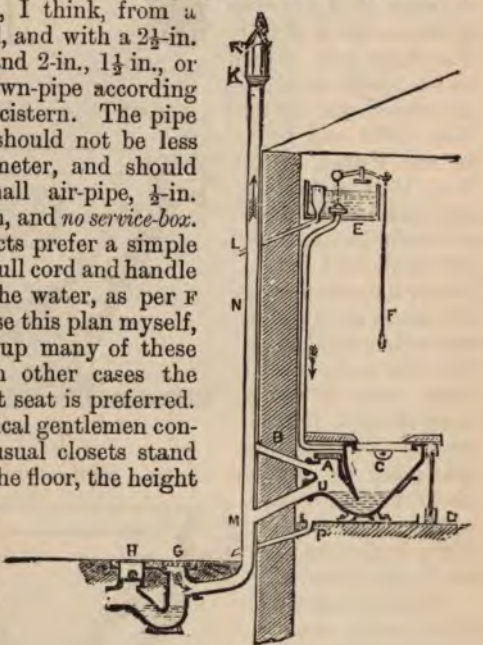


Fig. 215.

Some architects prefer a simple pull-down bell-pull cord and handle for letting on the water, as per F in Fig. 215. I use this plan myself, and have fitted up many of these closets so.* In other cases the lifting handle at seat is preferred. As various medical gentlemen consider that the usual closets stand too high above the floor, the height of this one is only 15½ in. If wanted up to the usual height it can easily be set upon a small block of wood slightly larger than the earthenware sole of the closet. This wood may be placed under the lead safe, where a lead safe is used.

It is recommended to use this closet with the following *sizes of* valves and service-pipe from cistern, according to *the height of the cistern* above the water-closet, viz., about

* *A check for the outer* end of the lever to strike against is useful, to *prevent it being pulled* down too far. India-rubber or felt for deafening *sound may also be* placed under the closet if wished.

6 ft. or less above closet, a 2½-in. valve and 2-in. service-pipe; about 8 ft. above closet, 2½-in. valve and 1½-in. service-pipe; about 9 ft. 6 in. above closet, 2-in. valve and 1½-in. service-pipe; about 11 ft. above closet, 2-in. valve and 1-in. service-pipe, with short tapered piece of pipe between valve and 1-in., &c., down-pipe. A good size of small wood cistern, lined with sheet-lead, is 21 in. long by 11 in. broad and 15 in. deep all inside, or as much *larger* as desired.

In towns, &c., where limited closet water-supply regulations are in force, either Ross's or other regulating valve of sufficient size may be used, or cistern with division and two common valves, or A. T. Bean's valveless waste preventer, or one of the siphon-action cisterns with 2-in. or 1½-in. down-pipe. It is necessary that the water-flush of this closet should come quickly and with force, so that there be no waste of water. Two or three gallons coming *quickly* and with a good force will do more good than ten times as much coming slowly, while two short flushes are better than one long one.

Notwithstanding the foregoing directions as to fitting up, the mistakes that various parties have made in fitting them are rather curious; *e.g.*, one party had a 2½-in. valve and 2-in. down-pipe from a small 2-gallon iron cistern, but only a 1-in. coupling between the valve and 2-in. pipe. Of course the flushing of the closet was a failure. I was appealed to to explain this, and desired the parties to take out the, in this case, stupidly small 1-in. coupling and use a 2-inch coupling. This was done, a 3-gallon cistern at same time being put in in place of the 2-gallon one, whereupon word came back that "now the closet works first-rate." Too large an air-pipe does harm.

When too great a flush is given or too much water is allowed to come into the basin of the wash-down closet at once, the water comes in too quickly, and so rises up in the basin too high. The plumber may easily remedy this by cutting off 6 in. or so off end of service-pipe *next the basin*, and putting in a short piece of pipe ¼ in. or so less in diameter. In a number of cases I have a few inches of 1-in. pipe next the basin with a larger pipe behind and above it, and the flushing first-rate. *It is easier contracting a too large pipe so than putting in a larger pipe where too small a one has been put in at first.*

*A broad* but shallow cistern, only a few inches deep,

not so good for flushing as a narrower but deeper one; *e.g.*, a depth of water of 12 in. above the valve will give a good flush when only 6 in. would give an insufficient one, and even with twice the quantity of water.

Figs. 216 and 217 are sketches of the "Carmichael" closet, in pedestal form, for fitting up exposed, with hinged flap seat.

Fig. 216

The title "wash-down," introduced by the author, is used to distinguish this style of closet from the "wash-*out*" styles shown in Figs. 207, 208, and 209. In the latter the water flows out sideways into the trap, the water in which is *out of sight*, while the pipe between the basin D and the top of the water in the trap at E, Fig. 207, is apt to get foul and furred where not seen. For this reason some prefer the "wash-down" to the "wash-out" style of closet.

Fig. 217.

Dr. Neil Carmichael, in the important paper read by him to the Philosophical Society of Glasgow, in February, 1880, on "The Trap and Water-Closet System," says: "A basin with its outlet so curved as to form a siphon-trap, the deepest part of which *is seen* from the basin, the whole formed of one piece of glazed earthenware, fulfils all the conditions of a simple, clean, safe, and cheap water-closet." These principles, including the necessary flushing arrangement, will be found *embodied in* Figs. 212 to 218.*

*There is a partial* resemblance between Figs. 209 and 213, *in that both have access* openings and lids with ventilating

* *In Glasgow, of late,* the Sanitary Authorities have been specially recommending "*Wash-down*" closets to be used.

horns beneath, as at B and K, but in Fig. 209 both are upon the *house side* of the trap, while in Figs. 213 and 214 both are upon the *outer side* of the trap. Carrying a ventilating pipe from the house side of the water-trap, or from the closet basin to the outer air, is foolish, as the cold air blows in in a disagreeable manner, and while doing no good may sometimes do harm.

Within the last few years considerable improvements have been made by many makers in the formation and appearance of both the "wash-out" and "wash-down" earthenware closets. This has been induced by the desire to do away with metal or machinery closets, and by the demand, as we have already mentioned, for exposed closets, *i.e.*, without the old usual wood casing in front of and around them; simply a narrow wooden hinged seat on top, so that the said appliance might serve both as closet and urinal, and sometimes also as slop-sink.

In cases where a black-looking deposit takes place below the water-line inside the closet trap, as, for example, at D D in Fig. 218 (which is an illustration of one of Shank's "Citizen" wash-down closets), this can be rubbed off with diluted muriatic acid. The depth of the dripping-tongue T below the surface of the water—alias, the water-seal—should be for wash-down closets 1½ in. and for wash-out closets, in which the water trap is more out of sight, 2 in. Some sanitary authorities, such as in Aberdeen, *e.g.*, insist strongly upon this. In those mansion-houses, &c., where the soil-pipes are fitted up without any disconnecting trap at foot, the whole atmosphere of the house or building is liable to be polluted with bad air from the drains should the water in any of those closets evaporate or get below the water-seal.

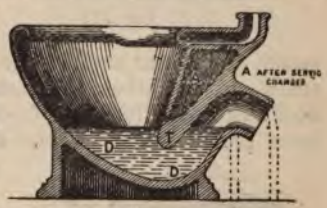


Fig. 218.

Fig. 219 shows one of Doulton & Co.'s "Simplicitas" "wash-down" closets with their new style of lead socket *soldered on to the earthenware of the closet*. At present Messrs. Doulton *prefer* to do the soldering themselves, sending out *their closets* in this style with the lead piece, or "lead *socket*," soldered on, as indicated in the drawing. Messrs

Doulton term this their "Patent Metallo-Keramic Joint."* Since seeing Messrs. Doulton's new joint, I observe that Mr. Twyford, Hanley, is also introducing what is termed "Twyford's Patent Porcelain-Metal Wiped Joint," two specimens of which, V and S, are illustrated in Fig. 220.

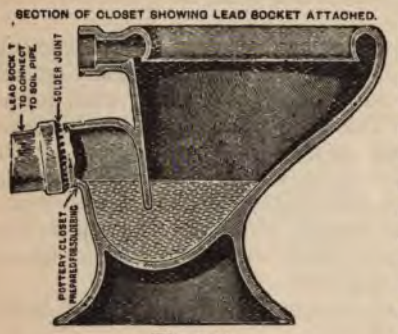

SECTION OF CLOSET SHOWING LEAD SOCKET ATTACHED.
LEAD SOCK T TO CONNECT TO SOIL PIPE.
SOLDER JOINT
POTTERY CLOSET PREMISES

Fig 219.

An old style of flushing closet often used to preserve economy of water in its working, and at same time insure a flow of water each time the closet is used, is the double cistern self-acting one, Fig. 221, where the act of pressing down the seat of the water-closet—which is hinged and fitted on purpose—causes the water to flow from the large cistern into the small one, and when the seat is allowed to rise—which it does automatically, being forced up by one end of weighted lever placed under it—the connection between the large and small cisterns is closed, and the valve M, which allows the water to rush down the water-closet service-pipe and flush the basin, opened.

Fig. 220.

To prevent the waste of water in water-closets, various plans and many "patents" have been brought out of late. Formerly, and in many cases still, so long as the handle of the water-closet was held up, so long did the water run; *now, however, the* water-economising plan is that when the

* *At the Sanitary Institute* Exhibition of Sanitary Appliances, held *at Liverpool in September*, 1894, the Medal of the Institute was *awarded to Messrs. Doulton* for their Metallo-Keramic joint.

handle is lifted no more than two* or three gallons of water run off to flush the basin. Before more water can be got the handle must be first put down and again lifted. This rule was really so far necessary, as in very many cases parties would prop up the handles of their water-closets and allow the water to run full bore for hours at a stretch.

In some cases it would almost appear that the saving, real or imaginary, of a few gallons of water per day—even with an overflowing fountain-head—was of much more consequence than the increase of the disease and death-rate through sewage gas poisoning from foul pipes and drains. The real waste of water is not the quantity used to flush a

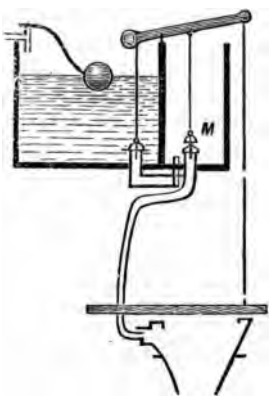



Fig. 221.

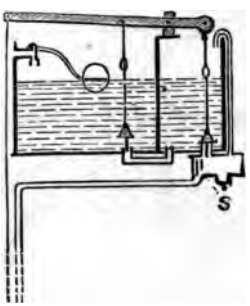



Fig. 221A

closet properly, but the continuous leakages from cranes and fittings out of order, or carelessly left running.

Fig. 221A shows another style of double cistern.

Instead of the double cistern with two valves, "waste-not" valves, which close of themselves, may be had for fitting into single cisterns. Messrs. J. Tylor and Sons, of London, invented one. A still more ingenious one was brought out by Mr. Connell, of Messrs. Wallace and Connell, Glasgow. In this the action of lifting the handle gives so much water and no more, thereafter upon pressing *down the handle* so much comes as fills the pan or basin.

* The *two*-gallon allowance is too little.

A size of those that may be large enough to flush a pan or Bramah closet is often much too small to properly flush a wash-out or a wash-down closet.

Mr. William Ross, brassfounder, Glasgow, has invented "waste-not" or self-closing valves, which are largely in use. These can be had in two or more sizes, and are cheap. One-flush small cast-iron cisterns holding only two, two and a half, or three gallons of water, have been much used for a number of years back to flush closets on the water-saving system. These small cisterns work in various ways, some on the siphon principle—the water-flush once started the cistern is emptied before it stops.

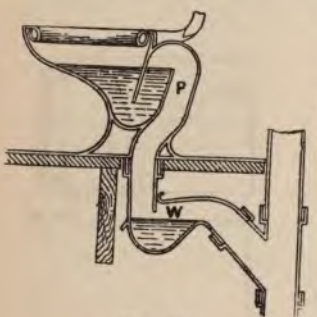


Fig. 222.

To enumerate the titles of all the closets now in the market would be difficult. The varieties of wash-outs are legion, while there are a number of wash-downs with differences in detail. Makers like Doulton, Shanks, Jennings, Craig, &c., &c., will supply catalogues on application. I may give sketch, however, of an American closet styled the Dececo, invented by Geo. E. Waring, jun., which is ingenious, although a little complicated by the extra semi-trap under the floor. The outlet passage P between the basin and the semi-trap or weir W, Fig. 222, acts as a siphon when the closet is flushed, sucking or emptying out the water from the basin, but leaving sufficient for a water seal in the basin. It is said that this closet is cleanly in use. It is made in one piece of earthenware. It will be observed that there is no air pipe on the branch soil-pipe, as this would spoil the action of the siphon. This want of ventilation for the branch soil-pipe is looked upon by many as a fault.

There has been considerable controversy as to the merits of the siphon *versus* the "D"-trap, for water-closets, &c. Some decry the D-trap altogether, on account of it being *more dirty than* the siphon-trap; others, keeping in view *the effect of siphon* action, consider the D-trap the safer

of the two. Mr. P. J. Davies, of London, has advocated the D-trap; while Mr. S. S. Hellyer, also of London, opposes its use, and has brought out the "Anti-D-Trap," Fig. 223, as an improved form of siphon-trap to be used in preference. Fig. 223A is vertical section of the D-trap. One objection to the D-trap is that the dipping pipe might be holed near A without being seen, and so allow foul air free passage through the trap above the water. Of course the application of the smoke test would reveal this fault.

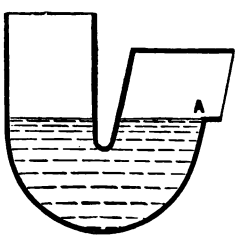



Fig. 223.

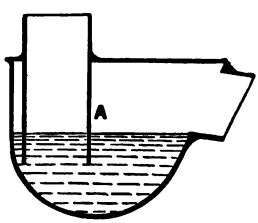



Fig. 223A.

Some detail explanations may here be given as to fitting in the lead traps for closets like the pan or Bramah, &c., which require to have traps fitted in below them. I may therefore observe that in setting the siphon-traps of the water-closets, as per Fig. 195, 198, and 203, the centre of the top of the siphon-trap is generally the centre of the water-closet basin above it, and in placing the siphon-trap into its position, the plumber must see that it is in its right place and at a sufficient distance from the back wall, due allowance being made for the thickness of the plaster or wood lining, &c.

The distance of the centre of the water-closet basin from the outside face of the back lining is generally about 12½ in. or 13 in., or perhaps a little more, and if outside face of lining be 2 in. (say) from the stone or brick wall at its back, then the distance of the centre of the top of the siphon-trap from the stone wall would therefore be 12½ in. + 2 in. = 14½ in. or so. Or again, when it is simply to be lime on brick, then about 13½ in. may serve between the face of the brick and the centre of the siphon-trap.

In the case of Fig. 202 the centre of the basin is not plumb above the centre of the siphon-trap, but the siphon-trap is placed about 10 in. or so to one side, as shown; the distance out from the back wall may be, however, the same in both cases.

After the siphon-trap has been properly fitted into its place, and the flooring laid above and round it, the plumber often lays down a lead safe or tray about 2 ft., 3 ft., or 4 ft. long, as the case may be, and about 2 ft. broad. It is turned up all round its outer edge, to the height of 2 in. or so. Upon this safe the trunk of the water closet (Figs. 198, 202, 203) is laid, being bedded with putty and fixed with brass screws or nails; the basin is also bedded with putty, or, in the case of Figs. 202 and 203, with red lead or cement, while the connection between the basin and "service," or supply-pipe, to it is made with putty and cement formed by melting rosin and tallow together. A lead or tin "fan," or water-spreader, is also fixed to the inside of the basin by two brass bolts and nuts, so as to cause the water to rush round the basin and cleanse it.* In the case of basin for Bramah closet a lead fan with horn is sometimes put on outside, *i.e.*, when there is no earthenware horn.

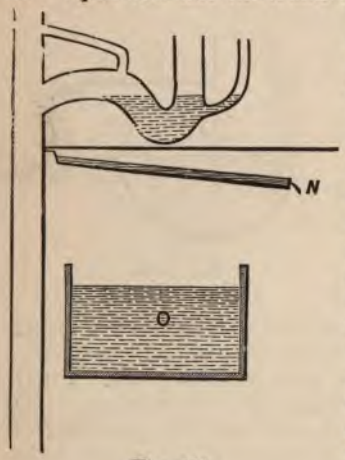


Fig. 224.

Instead of using putty and cement, with a strip of cloth and twine to make the connecting-joint between the basin and supply-pipe, a new plan is to use a tapered india-rubber coupling or cone, open at both ends, and about 2¾ in. long; the small end grasping the supply-pipe and the larger end the horn of the basin.

* I prefer the water to flow out at both sides of the fan. When only *at one side there is greater* danger of flooding should valve stick, owing *to the flushing water working* upwards like a screw and overflowing *the basin.*

It is incumbent upon every true architect, and upon all who have it in their power, to see that the water cistern is properly protected. One style of doing this where cisterns are so placed as that the cistern of one flat or house is immediately under the water-closet in the flat or house above it, as shown by Fig. 224, where a wooden board, N, longer and broader than cistern, and covered with lead, s fixed in above the cistern and close to the ceiling at its back, but with a little inclination downwards and outwards to the front as shown. In this case, supposing the water-closet above to be out of order and overflowing, then any foul water coming down cannot get into the cistern O, underneath, but instead falls down beyond it and on to the floor, thus at once giving warning that something is wrong.

From inattention to what I am referring to, and the want of some such protection as the board N in Fig. 224, it was no uncommon occurrence for the occupants of houses which drew their whole water supply from cisterns situated as in Fig. 224, to be using water tainted with the droppings from the water-closet above. This poison-my-neighbour system has got a great check in late years, owing to stricter attention being given to the sanitary arrangements of the plumbing work. The development of hygienic plumbing is one of the many benefits to humanity which the last quarter of this nineteenth century has evolved.

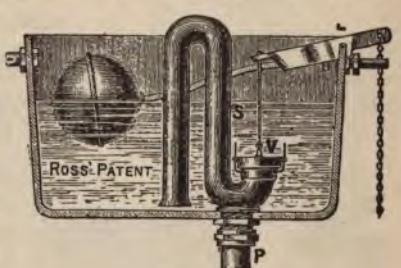


Fig. 225.

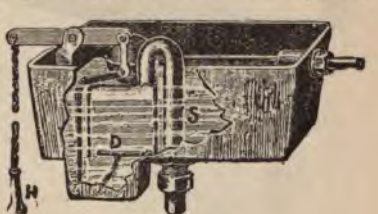


Fig. 226.

All water-closets, especially in dwelling-houses, should be fitted up where the daylight can reach them, and preferably next an outer wall. *The window* should be in two halves to lift up and down,

or open, like an ordinary window, so as to be capable of being used for ventilating purposes. It is a good plan to let fresh air in between the sashes of the window, so that it may take an upward direction, and disagreeable draughts not be so readily felt. Fig. 23 in the author's Text-book on "Ventilation," No. 271 of Weale's series, illustrates this. Daylight admitted into a water-closet apartment generally insures its being more cleanly kept.

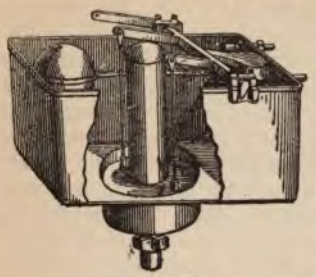


Fig. 227.

This article may be concluded with some illustrations of small iron waste-preventing cisterns. In Ross's siphon cistern, Fig. 225, the siphon S is started when the lever at L is pulled down, as this lifts the valve V, and allows the water to flow into the service-pipe P.

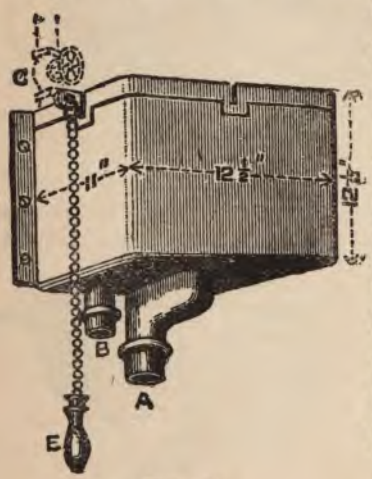



Fig. 228.

In Adam's cistern, pulling the handle H, Fig. 226, raises the displacer D, which forces the water up into the siphon S, and starts it.

Fig. 227 is one of Shanks' with a well or dip in which an annular disc works, and through the centre of the disc stands the siphon-pipe. The disc is depressed by the lever, and immediately starts the siphon, emptying the cistern quickly.

Fig. 228 is elevation in perspective of one of Mr. S. S. Hellyer's siphon *cisterns.* B *is the* overflow, C the supply. A *is the service-pipe to the basin.* Pulling down the handle E lifts or *opens the valve which* charges the siphon (somewhat as in

Fig. 230). When the larger compartment of the cistern is empty the flush ceases, and the ball of the ball-cock in the small compartment, as shown at c, Fig. 229, falls, and the water re-fills the cistern. Fig. 229 is a horizontal plan of the cistern. The iron lever may be placed at either a, b, or c.

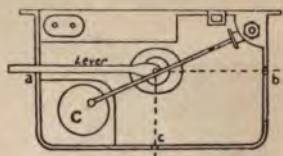


Fig. 229.

Fig. 230 shows Ross's self-acting waste-not valve in a 3-gallon iron cistern. The valve is shown as shut, and with the sucker or lifter suspended a little above it. Pulling

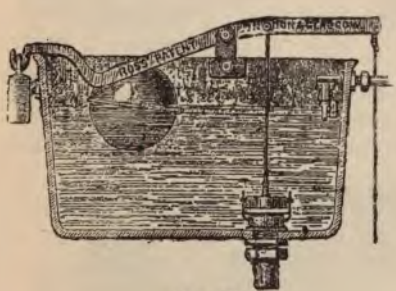


Fig. 230.

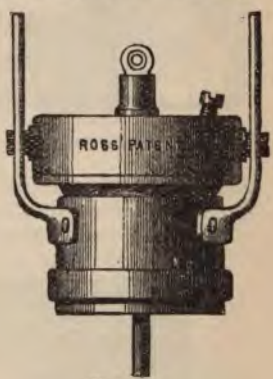


Fig. 231.

the handle, chain, or cord, lowers the lever and the sucker with it, then the handle being let go, the sucker lifts the valve and keeps it suspended until 3 gallons or so of water are run off, when the valve drops away from the sucker and closes.

This waste-not valve may be fixed in any size of cistern; many of them are in use in Glasgow and other places. Fig. 231 shows an enlarged view of the valve suitable for being soldered into the bottom of a lead-lined cistern. The sucker in this case is shown as resting on the valve.

Fig. 232.

projection appears on each side of the sucker, and these projections keep the sucker in position by help of the two vertical guides or slots in which they work.

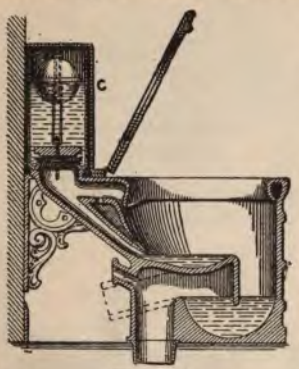



Fig. 233.

Fig. 232 is a sketch of Winn's siphon cistern Of late I have used a number of Grant's cisterns. There are still others in the market, but the foregoing will suffice for our purpose here in relation to cisterns set at about from 4 ft. to 9 ft. or so above the closet.

Fig. 233 shows a closet and cistern combined. This is suitable in cases where there is little head room, as the total height to top of cistern from floor in this instance is only about 3 ft. The diagram is from one of Shanks' styles, and the closet may be had either with **S** trap as shown, or with **P** trap as indicated by dotted lines.

Many of the water-closets are fitted up now with seat

Fig. 234.

*without a lid, as per* Fig. 234. The seat being hinged the *closet may be used as* a urinal by lifting the lid.

*Fig. 234A is sketch* of a side-outlet wash-down closet. *Fig. 235 shows* a hinged seat with hinged lid. Fig. 236

again shows a hinged seat with a spring at S, which always keeps the seat up. This seat is specially suitable for being fitted on where the closet also serves as a urinal, and may-hap likewise as a slop-sink. When the closet is to be used

Fig. 235.

Fig. 236.

as a closet, the seat is pushed down to the horizontal position by hand.

Fig. 237 shows a single valve ship-closet, Shanks' "Atlantic" pattern, with the basin encased in iron for greater strength and better protection.

Fig. 234A.

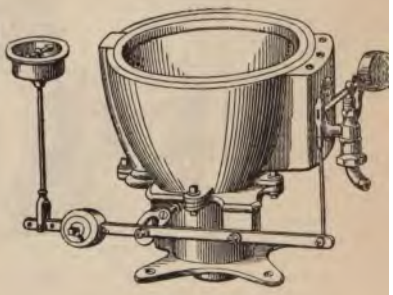


Fig. 237.

Fig. 238 shows the double-valve style with the basin *encased in iron.* A is the after service-box for letting water *into basin to fill it up.* B is the access-door to service-box. *C and D are* doors for access to overflow. These closet

have been fitted in many of the first-class ocean-going Liners.

Figs. 239 and 240 are sectional and perspective views of

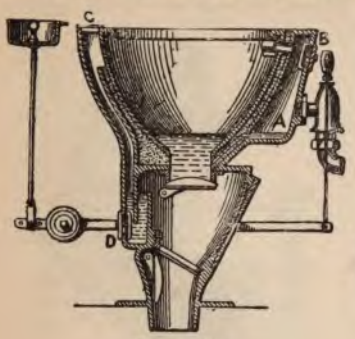



Fig. 238.

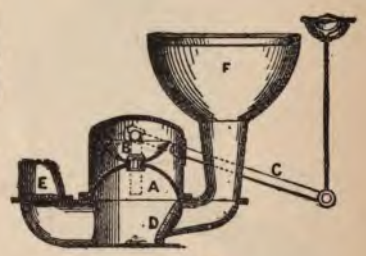



Fig. 239.

under-water-line pump-closets for ships, yachts, torpedo-boats, &c. The pumping action is obtained by means of the india-rubber diaphragm A, of spherical shape, which is

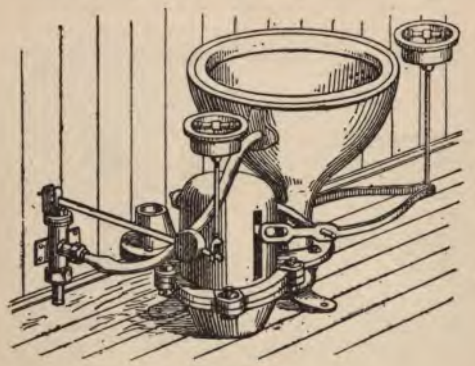


Fig. 240.

depressed and raised by the metal cap B, working in connection with the lever C. The two check valves E and D complete the pump. In case of the india-rubber diaphragm A going wrong when at sea, especially during a long voyage, a spare diaphragm should be carried in the vessel

# CHAPTER XVII.

## BATHS.

WE now come to treat upon baths. The simplest style of bath, and one which serves its purpose very well, is the wooden one. It may be made either quite square at both ends, as per Fig. 241, which gives longitudinal section, or one end may be sloped as per Fig. 246. It is made of 1¼-in. wood, planed on both sides, and jointed as per Fig. 242, the ends being checked or inserted into the sides to the

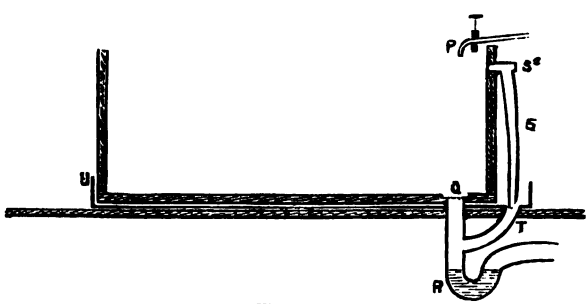



Fig. 241.

depth of about ⅝ in., white lead being used for the joints. It is then nailed together. After the bath has been made, the plumber has to fit it up, which may be done in various styles. The simplest is that shown by Fig. 241, where the bath is filled by a simple bib-crane P, and the waste water discharged at the socket-grating Q. Into the socket-grating Q, a brass *or india-rubber* plug fits. It is put in when the *bath is to be filled,* and withdrawn when it is to be emptied. *This brass plug* has a strong brass chain attached to it, th

other end of the chain being fixed to or near the top of the bath. R is the 3-in. syphon-trap underneath the bath, while S is the overflow-pipe which leads into the safe-pipe, T. This safe-pipe, T, takes any water away which may fall into the lead safe, or tray, U, should the bath happen to leak at the bottom or seams. The lead tray is set up at the ends and sides about 4 or 5 inches.

The top of the lead siphon-trap just under Q, where it passes up through the lead safe, is, of course, soldered round to the lead safe. Sheet lead, 4 lbs. per square foot, does very well for this lead tray. When fitting up this and all other plunge-baths, the plumber ought to be careful to see that the bath is so placed as that, upon the withdrawal of the plug, all the water runs easily out of the grating Q. For this purpose, the end of the bath at Q ought to be the lowest, while the other end ought to be raised up a little higher.

In the case of Fig. 241, three slips of wood, each about 6 ft. long, 2½ in. broad, and about 1¼ in. thick at one end, regularly reduced to about ⅝ in. thick at other end, should be placed underneath the bath. These slips will not only give the bath the necessary declivity to Q (supposing the floor to be level), but, in the case of Fig. 241, also prevent the bottom of the bath from lying soaking in any water which might get into the lead safe U.

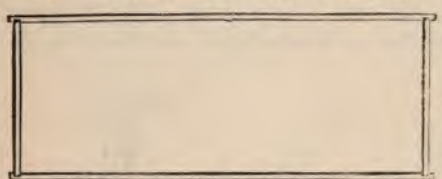


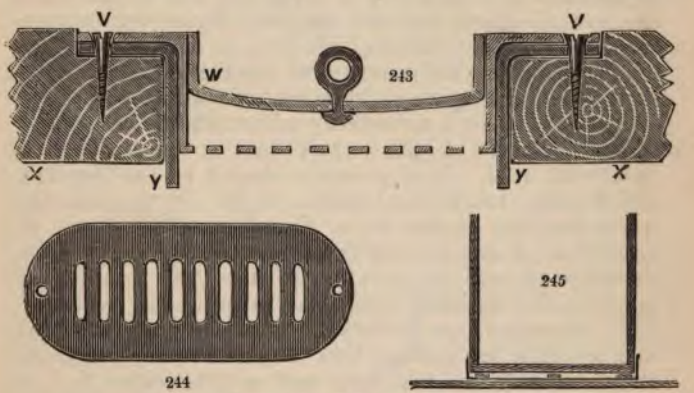
Fig. 242.

Fig. 245 shows cross-section of bath, with the wooden slips referred to under it. To give satisfaction, it is very necessary that proper brass gratings are put in, especially for the bottom one at Q. Fig. 243 shows section of circular brass socket-grating and plug *in situ*, the diameter over all of this socket-grating, from V to V, being 5⅜ in., and the diameter over all of the plug W fully 3 in.

The breadth of the top flange V is about 1 in.; it has *four holes bored* and countersunk in it, for 1-in. brass *screws to fix the* socket-grating down to the bath. X X, *Fig. 243, is the* wooden bottom of the bath, and Y Y the top of *the lead siphon-trap,* R, Fig. 241; or, rather Y Y is the top

of a short piece of $3\frac{1}{4}$-in. lead pipe joined on to the top of the siphon-trap, going up through the wood, and bent over the wood and under the brass flange, as shown. Before the lead is bent, or worked over, it is well coated, on the side next the wood, with white-lead, so as to make a tight joint. It will also be observed that at v v, Fig. 243, the wood is checked down, or cut out, to the depth of $\frac{3}{8}$ in., so that after the lead has been turned over, and the brass socket-grating put in, the top of the brass may be rather lower than the surface of the bottom of the bath, which allows all the water to run off freely.

Fig. 244 shows the style of the brass overflow grating




Figs. 243, 244, and 245.

used for the wooden bath; it is $6\frac{1}{2}$ in. long by $2\frac{5}{8}$ in. broad over all, and $\frac{1}{8}$ in. thick. The wood of the bath is checked out about $\frac{1}{4}$ in. where it goes, thus allowing for the thickness of the lead and brass, so that, when fixed, the face of the brass may be flush with the wood. I have said that the size of the brass overflow-grating is $6\frac{1}{2}$ in. by $2\frac{5}{8}$ in., but the lead mouthpiece, $s^2$, Fig. 241, while also of oval form, is only $4\frac{3}{4}$ in. across by $1\frac{1}{2}$ in. wide, the hole cut through the wood of the bath being made to fit the lead mouthpiece, i.e. about 5 in. long by $1\frac{3}{4}$ in. wide.

*In Fig. 241 only* one crane is shown, as if the bath were *only for cold* water, but all that is necessary to make it *serve for both hot* and cold, is simply to put on a hot cran

(provided you have hot-water supply) either alongside P, Fig. 241, or else at the other end of the bath, just as may be most suitable. These wooden baths do not require to be lined up along the front, but merely up the ends, or if the bath be in a corner, up the one end; a piece of wood skirting, however, about 6 in. broad, goes along the bottom of the front.

In some cases, however, and especially where the wood for the sides is put on in two pieces, this bath is lined up the front, which lining hides the view of the seams from the outside; in this case the wood lining should not be put on close to the wood of the bath, but should be kept apart about half an inch, so that any water which may ooze out at the seam may trickle down unchecked into the lead safe, the upstand of said lead safe being kept back from the wood of the bath about half an inch or so, as shown at U, Fig. 241, so as to allow the water to fall into the safe freely. Due attention to these apparently little matters often makes all the difference between a satisfactory and an unsatisfactory job.

Another style of bath largely used is the wooden one lined with lead. It is generally shaped as per Fig. 246, which shows longitudinal section of it. In this case the wood does not require to be planed, as it is all hid or covered in. A common size is 6 ft. over all in length, which, as the wood used is 1½ in. thick, gives 5 ft. 9 in. for the length *inside*, the inside breadth and depth being each (say) 2 ft. Sometimes the inside length is more than 5 ft. 9 in., and also often less, perhaps 5 ft. 6 in., or 5 ft. 4 in. In lining this bath with lead, the lead used may be either 6, 7, or 8 lbs. per square foot, as the case may be; if for hot water, it is better to be strong. For cold water alone the lead used is often only 5 lbs. per square foot. The plumber cuts out the lead for the ends and bottom all in one piece, and if we suppose the inside length of the bath to be 5 ft. 9 in. and the breadth and depth each 2 ft., then the length of the lead for the bottom and the ends will be 2 in. + 2 ft. + 4 ft. + 2 ft. 3½ in. + 6 in. + 2 in., which gives 9 ft. 1½ in. by 2 ft., as the size of the piece of lead for the bottom and ends. The two pieces of lead for the two sides are then cut out in shape as per Fig. 247, the greatest length of each being 5 ft. 9 in. along the top, and the depth 2 ft. + 2 in. = 2 ft. 2 in. The length along the bottom is 4 ft. These sides being *fitted* to the bath, and the edges of the lead planed straight, *they are smudged* down each side and along the bottom,

and then scraped all along the edge where the soldering is to be, about ¾ in. broad. After being scraped, the cleansed surface of the lead is rubbed over with grease or tallow. The bottom piece of lead, being also smudged, scraped, and greased, is put into the bath first, and dressed into its place properly, after which the sides are put in and tacked all

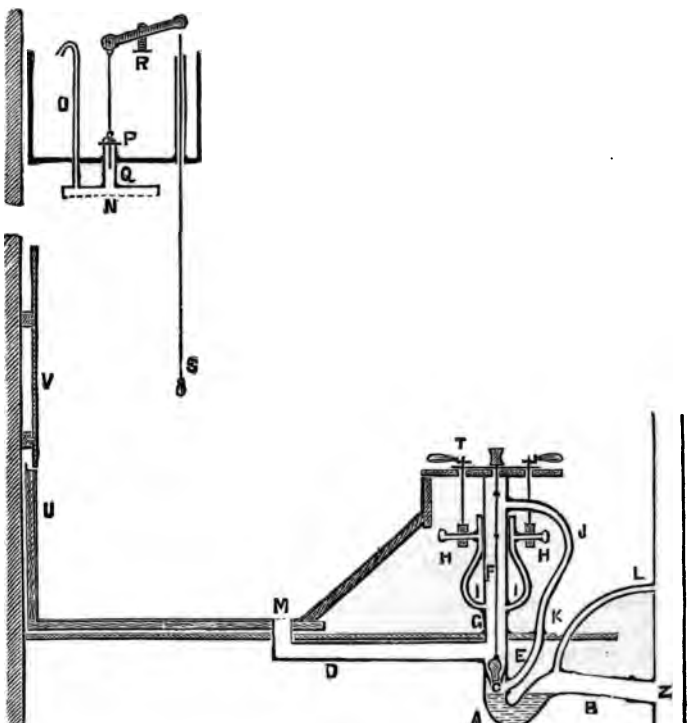
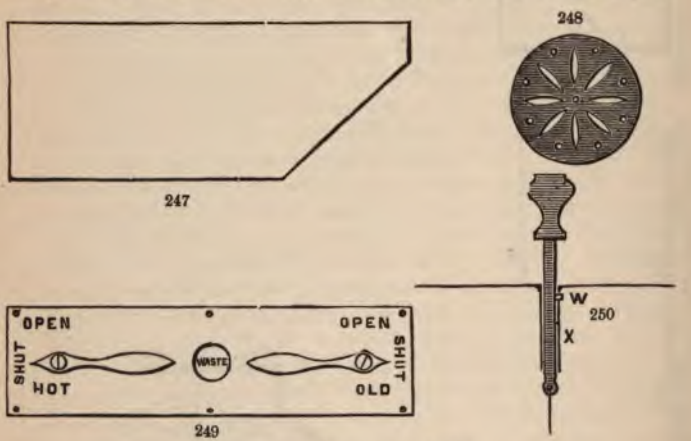



Fig. 246.

along the site of the soldering with ¾-in. tinned iron tacks, one being put in between the edges of the lead at every 4 in. or so. After each side of the bath has been soldered, or "wiped," small pieces of sheet lead, each 2 in. square, are soldered into the top corners of the bath with a copper bolt, to make up the deficiencies of the lead there, caused by said lead being *folded back* over the top edge of the bath.

The bath is now ready to be fitted up, and instead of doing it as per Fig. 241, we shall suppose it is to have a rod-pipe, ground brass valve, and hot and cold water supply, and also cold water shower-bath above. As in this case the waste-pipe of the bath is to be discharged into the soil-pipe, Z, Fig. 246, a branch has been left at Z, as shown, for that purpose.* The first thing to be done is to put in the 3-in. siphon-trap A, Fig. 246, with the 3-in. waste-pipe, B, attached; but before doing so, the socket of the valve C, Fig. 246, has to be soldered in, and also the branch D, to




Figs. 247, 248, 249, and 250.

the bath, likewise portion of bath overflow pipe sufficient to go up through the floor, as at E.

As will be seen from Fig. 246, the branch D, to the bath, joins in at the end next the siphon-trap, a little above the valve. In order, therefore, that it may have something to join into, when the valve socket, C, is put into the top of the siphon-trap, about 7 in. or 8 in. of 3-in. lead pipe is soldered on to the top of the lead siphon-trap along with the valve-socket; this 7 in. of 3-in. pipe, while it has the branch pipe D, which goes under the floor, inserted into it, *must also be left of* sufficient length thereafter to pass up *through the floor* and be flanged back about ¾ in. on the *floor, after the flooring* has been laid.

* *See foot of page 153* as to joining waste-pipes into soil-pipes.

This flanging back after the flooring is in helps to support the siphon-trap (the joiner must be ordered to fit his flooring neatly and properly around the pipes, rounding off the sharp edge of the wood wherever the lead has to be turned over it), and to this part flanged back the bottom of the rod-pipe, F, is afterwards soldered, as at G. This rod-pipe, F (so called because the rod or wire of the valve works up through it), is a piece of 3-in. lead pipe, about 2 ft. 2 in. long. *In situ* its top is level with the top of the bath, and should the depth of the bath be either more or less than 2 ft., its length must of course be in proportion. The sheet lead used for these pipes ought not to be less than 6 lbs. per square foot, and may with advantage be 7 or 8 lbs. The same may be said of the lead for the siphon-trap and the waste-pipes.

Before the rod-pipe is set into its place, it has first to be mounted with the hot and cold water cranes, H H. These in Fig. 246 are two stuffing stop-cocks with ground keys (when of good brass and properly fitted they do well for pressures about or under 20 ft.; for higher pressures screw-down or valve-cocks can be used), one end of each being inserted into and soldered to a piece of 1-in. lead-pipe, of say 10 lbs. per yard, and 18 in. long. The two cranes being soldered to 1-in. pipe, after the pipes have been bent into harp shape shown, the top ends of the pipes are soldered up, and the pipes afterwards joined to the rod-pipe at I, I; and in order to keep the cranes steady, the backs of the 1-in. pipes next the rod-pipe, at the height where the cranes are joined, are attached to the rod-pipe by being bolted or soldered thereto. The overflow pipe J, made of 2-in. lead pipe, is also joined to the rod-pipe, being attached from about 4 to 6 in. down from the top. After all these have been joined to the rod-pipe, the rod-pipe is then fixed into its place by being soldered at G, while the overflow-pipe is also soldered at K. The hot and cold cranes are then attached to their respective supply-pipes.

In order to show the principle of fitting up rod-pipes as clearly as possible, I have drawn Fig. 246 with the rod-pipe and the two cranes end on to the end of the bath, but in my experience the rod-pipes and cranes are more generally fitted up across, or along the end of the bath; the rod-pipe being placed *quite* close to the end of the bath, and the *overflow-pipe, in* place of bending out from the rod-pipe, as *far as is shown* in Fig. 246, is pretty close to it—perhaps

1½ in. between the two, the two cranes being joined to the rod-pipe, one at the back and one at the front, while the overflow pipe is attached to one side of the rod-pipe, the other side of the rod-pipe being close to the end of the bath; however, the principle in each case is the same.

The pipe shown at L, Fig. 246, is a ventilating pipe for the bath waste-pipe; it is here shown joined to the soil-pipe, but it may be carried up independently to the roof; 1-in. lead pipe, 8 lbs. to the yard, will serve for this purpose, or, if the expense is not grudged, 1½-in. pipe may be put in in preference. The use of this pipe L is to prevent the rush off of the water from emptying the siphon-trap, in addition to ventilating the pipe B. With small waste-pipes there is great danger of the siphon-trap being emptied, especially where there is no ventilating pipe in, but with large waste-pipes there is much less danger.

In tenemental houses, where a bath is fitted up for each house on each flat, the bath in one house or flat being perpendicular with the bath in other houses above or below, if it is not wished to join the ventilating pipe L to the soil-pipe, a 1½-in. or 2-in. drawn or hand-made lead pipe may be carried up all the way to the roof from the lowest bath, the 1½-in. ventilating pipes of the other bath siphon-traps branching into it.

After the rod-pipe and its fittings have been put in, the bath may then be lifted into its site (in many cases, of course, the bath is set in before the rod-pipe, and in Fig. 246 the pipes under the floor being all in, it matters little whether the rod-pipe or the bath be put in first); but before doing so, a hole 3½-in. in diameter has first to be cut at M, Fig. 246. After being cut right through, the lead inside and around this hole is lifted up a little by the plumber and the wood cut away in a sloping style for about ¾ in. back all round the hole, the lead is then dressed down, smudged and cleaned, and the bath then lifted into its place. When there, the top part of the branch D, Fig. 246, being cut to the necessary height, it is flanged back about ½ in. at M, and the brass rose grating, being tinned at edge, covered with paper temporarily and put down, one soldering joins the lead *bottom of the* bath, the lead pipe D, and the brass grating *altogether at* M.

*Fig. 248 shows* a common style of this brass rose-grating. *It is simply a* brass perforated disc about 3¼ in. in diameter,

and about ⅛ in. thick. It is generally cast. The plumber's work of the plunge-bath being thus far finished, the shower bath, N, Fig. 246, is next put up, being attached to the bottom of the cistern. It may be either a round one, 1 ft. in diameter, or else oval, and about 1 ft. 6 in. by 11 in. O is the ¾-in. air-pipe which allows the shower to empty after the valve P has been let down; Q is 2-in. or 2½-in. lead valve-pipe attaching the shower to the cistern; R is an iron lever, supposed to be screwed to a wood board laid across the cistern, while S is the cord and pull by which to work the shower. When S is pulled down it lifts the valve P, and the water falls; when S is let go the valve P shuts and the water stops.

Fig. 249 shows top view of a brass index-plate for the working apparatus of the plunge-bath fittings, with the two lever handles of the cranes, and the brass knob for the working valve; the index-plate is put on after all the pipes, &c., are covered in, and the woodwork of the bath finished. In Fig. 246 it is put on at T. Fig. 250 shows the valve knob —marked "waste" on the index-plate—in position when the valve is lifted up or open, the small pin, W, being turned into a notch cut for it to rest on; when the knob is lowered to shut the valve, the pin, W, slides down in the slit cut for it in the brass tube X, Fig. 250.

At U, Fig. 246, it will be observed that the lead stands up ½ in. at the back of the wood lining V; this is to prevent any water getting down the back of the plunge-bath or going on the floor when the shower-bath is used. Fig. 246 being longitudinal sectional view, the wood lining, V, which is put up between the top of the plunge-bath and the wood lining of the bottom of the cistern, though only shown there at the end of the bath, is also carried round about 2 ft. on each side of the bath.

In reference to the simple wooden bath and also the wooden bath lined with lead treated on above, it must be clearly understood that in fixing on the bottom, the boards forming the bottom must be put on across the bath: this may be inferred from Fig. 245. Sometimes the joiner, without thinking, puts on the bottom-boards longitudinally, but that is wrong. For wooden bath, such as Fig. 241, the bottom-boards should be jointed as per Fig. 251, which gives *sectional view*, a slip of wood or "feather" being inserted in *the centre* of the joint, as shown, and white-lead also used.

The same should be done with the sides and ends where the boards are not put on all in one, *i.e.* of the full depth.

In cases where the floor under the bath is off the level, and especially when the dip is away from and not towards the safe-pipe, to prevent water lying in such safes as shown in Fig. 241, before laying down the lead safe cause the joiner to lay down wooden boarding under it; *e.g.*, if the floor were off the level ½ in. in the 6 ft., then the joiner makes his boarding full size of sole of safe, and about ¾ in. thick at one end, and regularly diminished to ⅛th at other end, as per Fig. 252.

Fig. 251.

In Fig. 246, there is shown the way in which the hot and cold water was generally admitted into bath when the bath had a rod-pipe: now, however, in many places, since our water companies have begun to take more interest in the unnecessary waste of water, instead of the water being allowed to enter the rod-pipe as shown at I I, Fig. 246, it must either enter the bath near the top, as at *y*, Fig. 253, or near the bottom, say at Z, Fig. 253. In other cases it may be made to flow in over top of bath, so that should either or both cranes be leaking, the leakage may be at once seen.

Fig. 252.

This style of filling the bath with water does not, however, interfere with the fitting up of the rod-pipe in all other respects, as shown at Fig. 246; all the difference is that the connections, or joints, at I I, Fig. 246, are done away with, and the supply enters the bath directly, as shown at *y*, Fig. 253, instead of first down rod-pipe and then rising up through bottom of bath like a fountain, as is the case in Fig. 246. In the case of Fig. 246, however, the water enters the bath with less noise, and less steam is also given off than in the case of Fig. 253.

*Fig. 253* shows an enamelled iron bath fitted up with rod-pipe and hot and cold water supply, the supply, as stated above, entering through end of bath near top, as at *y*, the waste water being discharged through waste-pipe A, at bottom. B B is a lead safe under bath (I consider that when

iron baths are fitted up with rod-pipe and valve it is proper to put lead safes under them), C is safe-pipe, or pipe which takes away any water which may fall into the safe.

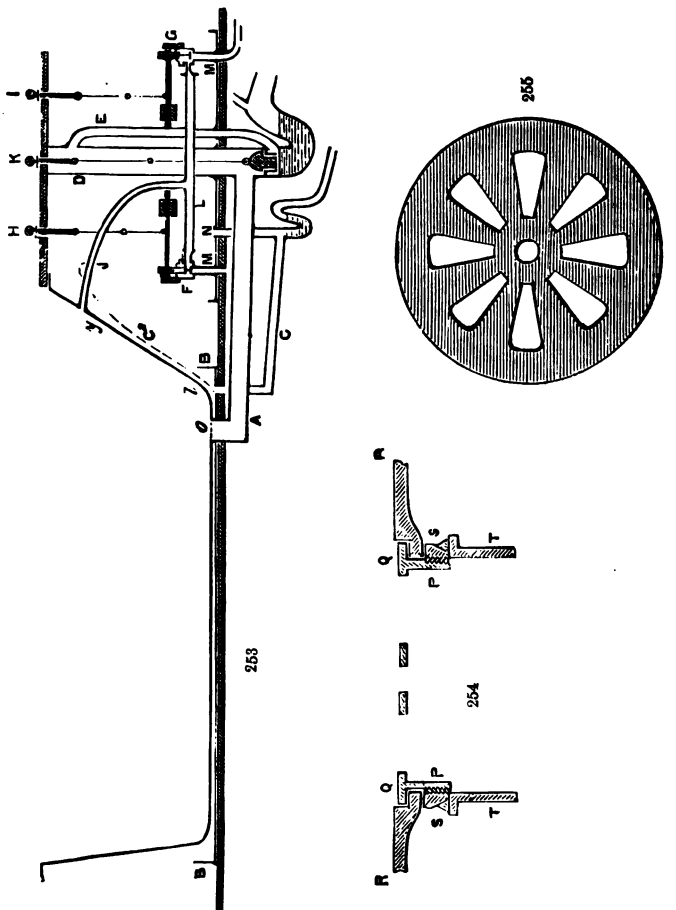
To prevent any chance of water coming back and overflowing up this safe-pipe C—say during frost—when the bath is being emptied, it might be arranged for it to go out independently of the bath waste-pipe or trap, and to have a siphon-trap for itself. If discharging into or over the drain, to prevent bad smell or cold draughts coming back, keep small siphon-trap charged by means of a small pipe led from the top of J, as per dotted line $C^2$, so that when the bath is being filled, a little water runs into small siphon-trap.

Tinned brass wire gratings should be put on at mouths of pipes C and N, Fig. 253. D is 3-in. lead rod-pipe, and E 2-in. overflow pipe. F and G are ¾-in. Lambert's hot and cold water valve-cranes, with weighted levers. When the knob H, Fig. 253, is lifted, it raises the lever of hot crane F, and hot water flows into bath through pipe at *y*. When knob I is lifted, cold water enters bath at *y*, and when both H and I are lifted at the same time the hot and cold water mix together in pipe J, and flow out in one stream at *y*. K is knob of waste-valve: when it is raised the bath empties, and when it is let down the bath can be filled. These three knobs, H, I, and K, all work on the same principle as that shown in Fig. 250.

In the sketches hitherto given the knobs are all shown as working perpendicularly, but they can also be made to work horizontally—being pulled out instead of lifted—when desired, the pipes being fitted in to suit. Figs. 320 and 324 farther on, show views of knobs and pulls which work horizontally. L, Fig. 253, is piece of 12 lb. 1-in. lead pipe, connecting the outlets of the hot and cold cranes. J is also piece of 12 lb. 1-in. lead pipe, joined to L at one end and to the bath at other end, at *y*. M M are the inlets of cranes, to which the supply-pipes may be joined in various ways. In order to fix these cranes, F and G, they are screwed to a piece of wood fixed up firmly at the back of each. It will also be observed in Fig. 253 that a lead safe is shown under the cranes with safe pipe, N.

Of *course the style* of fitting-up in Fig. 253 is much more *complicated than* that shown in Fig. 241 or in Fig. 286; but *it must be remembered* that, while there are many who wish

their baths fitted up as simply and cheaply as possible, there are others who are ready to pay ten times as much

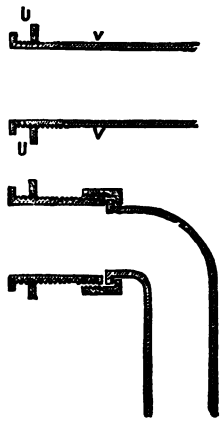



Figs. 253, 254, and 255.

*if things are made* to please them, and who, not content *with the hot and* cold supply to bath, as shown in Fig. 253, *will also have other* three, five, or more cranes, &c., besides;

say one cold for drinking, hot and cold for spray bath, and hot and cold cranes, with india-rubber pipes attached, for directing water to any part of the body where wished. These latter are useful in rheumatic complaints.

Fig. 254 shows section of brass grating, o, Fig. 253, *in situ*. It must be made to fit the hole left in bottom of bath for it; this must be especially attended to in the case of enamelled iron baths, for any attempt to enlarge the hole afterwards, or cut a new one, injures the enamel. Fig. 255 is top view of this brass grating. It is about 3 in. diameter over all. P P, Fig. 254, is pap, or horn of grating projecting down through bottom of bath, and screwed on the outside. Underneath Q Q (that is between brass flange and bottom of bath, R R) a bedding, say of red lead and hemp, or other suitable material, is placed. S S is strong brass ring screwed inside. It is soldered to lead waste-pipe T T, the brass grating being screwed into S S after bath is in its place.



Figs. 256 and 257.

Fig. 256 is the brass coupling used at *y*, Fig. 253, where the supply enters bath; U U is the back, or jam-nut; the tail at V V is left plain, so that lead supply-pipe may be soldered to it. The internal diameter of this coupling is 1 in., and its length about 3 in. Fig. 257 is another style of same. When an iron bath is fitted up with a simple brass socket-grating and plug (as per bath in Fig. 286), then, in place of the overflow on the rod-pipe, brass couplings—with gratings added—such as Figs. 256 or 257, may serve for the overflow; they should be made larger, however.

We may here say a few words about marble baths, although these are not now fitted up so often as they used to be. In many cases they were found in practice to be more ornamental than comfortable. They are generally put together as follows:—The piece which forms the bottom is about 6 in. longer and broader over all than the inside size of the *bath; this* allows a check to be cut in it 1½ in. broad and *about* ⅜ *in.* deep all round, besides leaving an outsi*de margin of* 1½ in. as shown by Fig. 258, which sho

longitudinal section. The marble used is supposed to be all 1½ in. thick, except the bevel piece L, Fig. 258, which is only about ⅞ in. thick. The pipes, cranes, and valve for Fig. 258 may be fitted up in the style shown by Fig. 253, but instead of the outlet on top of waste-pipe being seen as at O, Fig. 253, it may be concealed by being put in at back of bevelled piece L, viz., at M, Fig. 258.

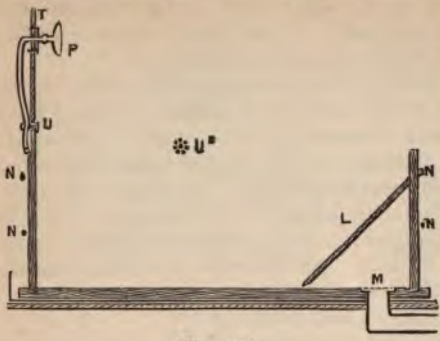



Fig. 258.

Fig. 259 is face of bevelled piece L, Fig. 258; it is about 2 ft. square, and has the bottom cut out to a height of about ½ in., as shown, so as to allow the water to flow out underneath it. The small projections, about 2 in. broad, left at each side, are let into bottom of bath a little, in order to keep the bevelled piece L in its place, and prevent it slipping down. This bevelled piece of marble L, Fig. 258, is merely put in for appearance sake, and is movable at pleasure, and being so, the portion of bath at back of it can be washed when wished.

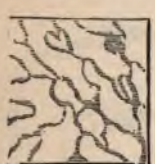


Fig. 259.

If the inside length of marble bath is to be 6 ft., then the three pieces of marble which form bottom and sides are each about 6 ft. 6 in. long, and as for the end pieces, they are grooved into the sides as per Fig. 242, Chapter XVII. Two long brass or iron (the former is best) bolts are also passed through each end of bath, as at N N N N, Fig. 258, with back-nuts to keep sides of bath together. Underneath marble bath a lead safe is placed, with waste-pipe, as per Fig. 253. For the joints of marble baths some use white *lead, but while it* makes a good joint, the oil in it *has the effect of* discolouring the marble near the joints. *Stucco, therefore,* is used by some, while others use Port*land cement; that,* however, pertains to the marble-cutter's

work. Slate baths are fitted in a similar way to marble ones.

Fig. 260 is sketch of a Rufford's—or other makers'*—stoneware or porcelain enamelled fireclay bath. These baths are very heavy to handle, but when fitted up properly they make clean-looking and first-rate baths. They can be fitted up on a similar principle to Fig. 253, or more elaborately as wished. As in making these baths they often get flawed more or less in the firing, the first or "perfect" quality have no flaws, while the second quality are imperfect according as there may be one or more flaws in the bath, *i.e.* cracks in its enamel, &c. Holes can be cut or bored in these baths for the brass fittings to suit situation.

We may now say a word about spray-baths. These are

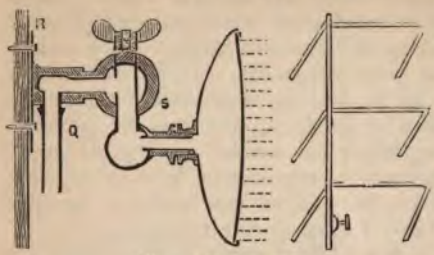
Fig. 260.

fitted up in various styles, such as the rose, tube, and case-sprays, either of which may be fitted up at the end of the plunge-baths, above referred to, as at P, Fig. 258, which shows section of rose-spray, supplied by water through one or two stop-cranes, according as there may be only cold supply to it, or both hot and cold. The sort of crane to be used may be either one with ground brass key or a screw-down one, just as may be most suitable for the pressure, &c.

The diameter of front or face of rose-spray may be about 6 in., or more if wished, the sheet-brass (or it may be cast) of which the perforated portion is made being pierced all over with holes so small as only to admit the point of a needle. This perforated portion or face of rose-spray ought not to be much rounded outwards, because if so the water is apt to spread out and scatter too much. A projection of

* J. and M. Craig, Cliff, &c.

about ⅛ in. in the centre will serve, and the number of small holes in a rose-spray 6 in. in diameter may be from 150 to 200. The rose-spray being jointed at back, the water from it may be made to flow out in the desired direction, higher or lower, as wished.



Figs. 261 and 262.

Fig. 261 shows sectional view, cut horizontally, of a rose-spray, with the supply coming in at Q (of ½ in. or ¾ in. bore, according to pressure), and being in front of the brass flange R, by which the rose spray is fixed to wood lining above end of bath; whereas the supply for spray-bath P, Fig. 258, comes in through lining to *back* of flange. The diameter of flange R, Fig. 261, may be about 4 in. The joint at S, Fig. 261, which allows spray to be moved up and down, is a common ground one, made so as to suit the purpose; but, instead, some use a ball-and-socket joint, as per B, Fig. 263. In fact, the roof-plate, including ball and socket, of a gasalier, if larger and stronger than ordinary, and with an extra large drop-screw (straight or knee'd, as most suitable), might serve, and might be that used at T, Fig. 258. It is better, however, and the proper way, to have joint specially made for the purpose; and, for my own part, I like the style of joint shown at S, Fig. 261, best.

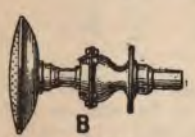


Fig. 263.

In Fig. 258 the water-crane at U for working the spray is shown a little below it: but, instead, it may be more handy to place it to one side of plunge-bath, and two or three feet back from spray-bath, as may be thought most convenient, as per $U^2$, Fig. 258.

The tube-spray can be made by placing a 1-in. or a ¾-in. copper, brass, or strong block-tin tube, or even a piece of ¾-in. 8 lb. lead pipe, about 2 ft. or 2½ ft. long, up one corner *of the bath—or up* centre of end of bath—with three or *more ½-in. tubes* branching off each side of it, as shown by

Fig. 262, where the height of the lowest horizontal tube may be from 6 in. to 9 in. above the top of the plunge-bath. The horizontal tubes have a number of small holes bored in front of them. The supply is regulated by either one or two cranes, as necessary.

The case-spray is set up on top of end of plunge-bath, and stands up, say 2 ft. or 2½ ft. or so. It may stand up not only across end of bath, but also come round each side about 18 in. or 2 ft. It is formed by taking a sheet of strong zinc, No. 16 or upwards, say 5 ft. long by 2 ft. broad, which being bent round to fit the end of the bath, above which it is to stand, is then bored full of holes to suit the position of the ribs put on at back. These ribs are small half tubes soldered on to back of zinc sheet, and all branching off from a large central "backbone," or main tube of (say) 1½ in. diameter. The spray-bath is a great favourite with many who are afraid of the regular shower-bath, as the water comes out as gently or more strongly as wished, and where there is both hot and cold supply to it, the temperature of spray can be made to suit.

In the case of the wave-bath, the water which comes out horizontally does so with much force, deluging the body in a moment. The amount of water and its force can of course be regulated by the size of pipe, valve or crane, and mouthpiece used. The mouthpiece may be either (say) 6 in. by ¼ in., or it may be 1 ft. by $\frac{1}{16}$ in., and if wished, a regulator to enlarge or contract the mouth may be put on.

Fig. 264 shows wave-bath supplied from cistern above it with 3-in. valve and lever; but instead, a crane or cranes may be used, leading water to a tinned copper or brass mouthpiece of any desired size or shape. The wave-bath is generally fitted up with but one mouthpiece; in other cases there may be two mouthpieces, in which latter case the water strikes the body on both sides at once. Too strong a wave-bath may be hurtful to some persons, especially if the water comes suddenly and more powerfully than expected.

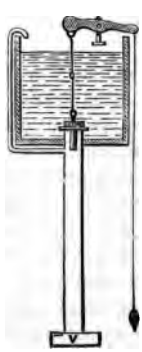


Fig. 264.

Where baths are fitted up near water-closets it is far too often the case to lead the bath waste-pipe into the soil-pipe. This *plan is open to* various objections, and especially where

hot-water is led on to the bath. It is a great improvement to keep the waste-pipe apart from the soil-pipe, by causing the former to either discharge above ground over a fire-clay trap, or else underground, into one of my 4-in. disconnecting ventilating traps. See Figs. 177, 410, 430, and 461.

This plan not only prevents the discharge of the closet sucking the water out of the bath-trap by siphon action, but also leaves no chance of sewage gas from the soil-pipe getting into or out of the bath waste-pipe. Much disease and death have occurred through the emptying of bath or basin water traps by the siphon action of discharging closets debouching into the same pipe; especially has this been the case in connection with closets of the Bramah type, and where the soil-pipe and the branch waste-pipes were insufficiently or improperly ventilated.

Since the foregoing remarks upon wooden, lead-lined,

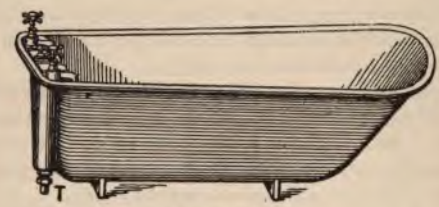



Fig. 265.

iron, and marble baths were published in the first edition of this book, a great development has taken place in the use of iron baths, and in their fittings, which it will be well to describe or illustrate somewhat here for the benefit of the rising generation of plumbers, many of whom were not born when the original of this work first appeared in print.

Fig. 265 is one of Shanks' plain-edge iron baths for fixing with wood lining around it. At the one end it has hot and cold screw-down cranes and waste-valve and knob. The brass coupling at T is for a 2-in. or 2½-in. lead trap to be attached to.

Fig. 266 is an iron bath with rolled edge all around the top. *This bath is* suitable for standing exposed without *any wood enclosure.* Like the former bath it has screw-*down cranes at one end* and the waste-valve and knob, but *in addition it has* an adjustable trap, T, above floor line, the

outlet of which can be turned in any direction desired by aid of the bolts and nuts arranged for the purpose.

Both of these baths can be had either japanned, metallic enamelled, or porcelain enamelled.

Fig. 267 shows vertical section of the trap and valve-pipe, also the water flowing into the bath.

In Fig. 268 we see an "Independent" plunge, spray, and

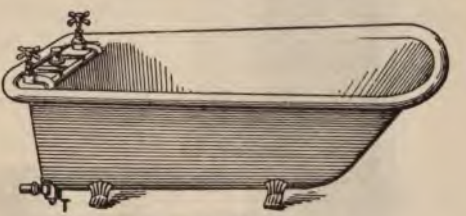


Fig. 266.

shower bath, which may stand out from the wall in the bathroom, as much or as little as desired, without any wood lining. The bath is enamelled inside and japanned outside. The plunge is of cast iron, while the spray may be either of zinc or copper. The exposed cranes and valve fittings are nickel-plated.

Fig. 269 gives perspective view of a cast-iron or copper

Fig. 267.

plunge bath, plate zinc or copper spray canopy—comprising spray, shower, and douche, with combined fittings for hot, cold, and waste. Bath and spray enamelled. The drawing shows bath, &c., enclosed in cabinet work.

Fig. 270 is plan of the plunge bath, the spray sitting upon it being made to correspond.

*In Fig. 269 it will* be seen that the waste-pull or valve-*knob, v, is lower* down than, and apart from, the three

handles working the hot and cold water cranes and the

Fig. 268.

Fig. 269.

*water-way director.* This arrangement, known as Shanks' "*Eureka,*" is further shown in Fig. 271, where H and C ar

the hot and cold-water supply cranes, and D the director which allows either the hot or cold water, or a mixture of both, to go out to either the plunge, spray, shower, or douche as desired, by turning the pointer on the handle, D,

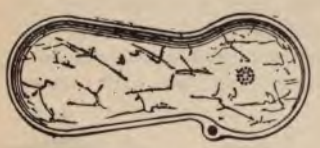


Fig. 270.

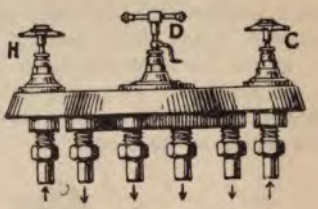



Fig. 271.

in the proper direction, as per the reading on face of the index-plate. In ordering baths like Fig. 269, it is better to get the short pipes from the index plate put in by the maker of the bath than by the plumber afterwards.

Fig. 272 shows a plunge bath with a circular spray set

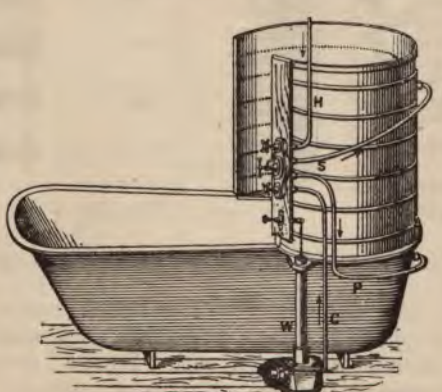



Fig. 272.

up above one end of it. H and C are the hot and cold *supply pipes leading* to the index plate mixing chamber. *S and P are the* water pipes from the mixing chamber to the

spray and to the plunge bath. W is the waste pull-pipe, with trap at foot.

Fig. 273 shows a skeleton spray bath made up with brass crosses and copper tubes.

Fig. 274 shows a combination bath-plate, with waste pull, and hot and cold inlet supply, and five outlets, viz., to shower, spray, wave, douche, and plunge.

It will be observed that, with only one pipe from the cock marked "Plunge," for example, either hot or cold water can be let on to the plunge bath, or a mixture of both, according as the cocks "Hot" and "Cold" are both opened,

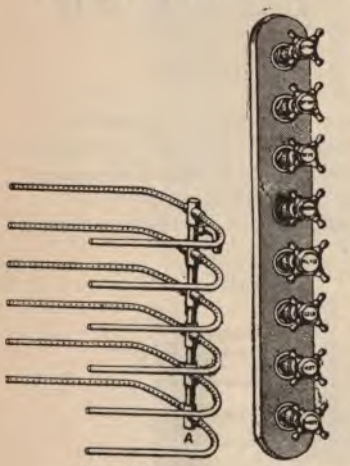



Fig. 273.

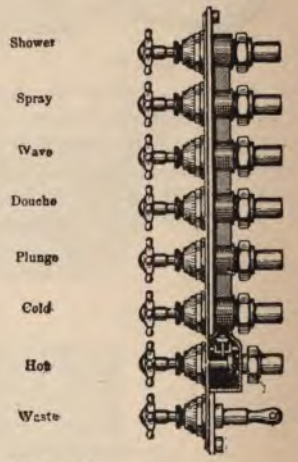



Fig. 274.

or only one, and so on with the douche, wave, spray, and shower.

Fig. 275 is a skeleton tube needle bath, made, say, of solid-drawn polished, tinned or electro-plated, copper tubes for spray, shower, and wave, with "Eureka" cock fittings and copper connecting pipes. It is shown with five upright tubes. The main back tube may be $1\frac{1}{2}$ in. internal diameter. The other four upright tubes may be $1\frac{1}{4}$ in. inside diameter. The nine circular horizontal tubes, $\frac{5}{8}$-in. bore. The shower may be of copper. "W" is the wave. The crosses and the connections are of brass or gun metal. Total height about 8 ft.

The entrance opening in front is 22 in. wide. Internal diameter, 3 ft. G is the grating in the floor over the trap or waste-pipe.

Fig. 276 is sketch of a sitz bath, made, say, of sheet copper, and either tinned or enamelled inside and bronzed outside, with hot and cold wave and back and bottom spray. W is waste pull.

Fig. 277 is sketch of a simple style of towel rail, which may be made up with either 2-in., 1½-in., or 1-in. brass or copper tubes, as wished, or a mixture of these. The foot-rests, tees, and balls are of cast brass. A is an air-cock to blow off the air, in order to allow the water to circulate; C C are the couplings for connecting to hot-water pipes.

Fig. 278 is another pattern of towel rail. These may be made up in various styles and are sometimes used as bath-room, lobby or stair-head warmers. When the air cock is not put on them an air-pipe may require to be put in to let out the air. In some cases this *air-pipe—which may* be of small bore—requires to be carried *out above the roof* so as to be at a higher level than the *top of the cold-water* cistern supplying the boiler.

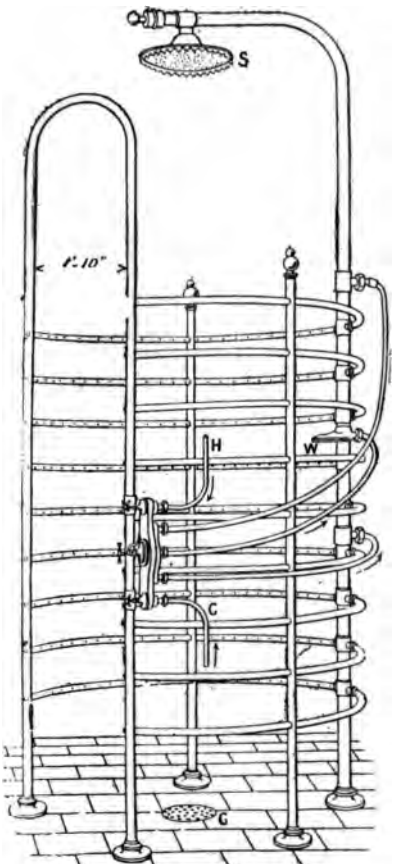



Fig. 275.

Fig. 279 is a sketch of one of Shanks' water heaters for heating water by gas where there is no hot-water boiler in

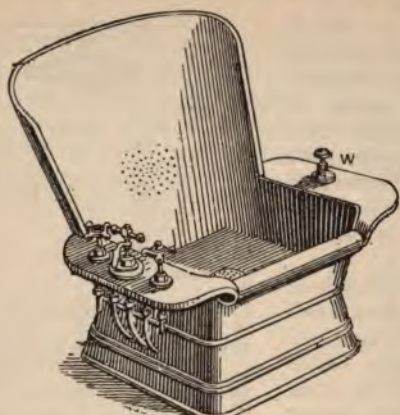



Fig. 276.

the house. One size gives a continuous stream of hot water at the rate of 1 gallon per minute, at 155° to 165°; 2

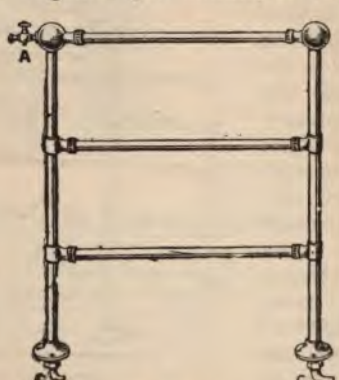



Fig. 277.

*gallons, at 120° to* 130°; 3 gallons, at 105° to 110°; 3½ *gallons, at 85° to* 100°; the gas supply pipe being ⅝ in. or ¾ *in. bore.* A smaller heater is said to give, with a ½ in.

gas pipe, ½ gallon per minute, at 160° to 170°; 1 gallon, at 120° to 130°; 2 gallons, at 100° to 110°; 2½ gallons, at 95°

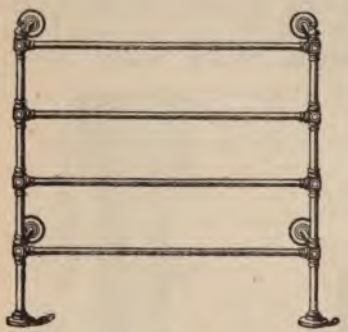


Fig. 278.

Fig. 279.

Fig. 280.

Fig. 281

*to 100°. minutes.* A hot bath at 105° is said to be got in about ten Of course this will depend so far upon the

initial lowness of temperature of the cold water at starting. A hot bath at 105° being much sooner got in summer or autumn, when the cold water is, say, 60° or higher, than in winter with the cold water at 40° or lower.

Maughan says of his No. 4 B Geyser, or water heater, that while it will give 40 gallons of water at 100° in nine minutes in temperate weather, it will give the same in six minutes in midsummer; but in freezing weather it will

Fig. 282.

Fig. 283.

require 15 minutes to do it. The consumption of gas is given at 25 cubit ft. for heating 40 gallons of water to 100° in temperate weather, which, when gas is 4s. per 1,000 ft. means nearly 1¼d. per said 40 gallons.

Fig. 280 shows one of Maughan's Geysers. He has an arrangement on the water crane by which, when it is *turned off*, the gas cock is also shut. This guards against *harm to the Geyser* by preventing it being burned or harmed *by the burning gas* when no water is in it.

*Fig. 281 is a small* Geyser fixed up against the wall; one

style of it will raise a pint of water to 80° in one minute, while another will do this to a quart in the same time. These appliances may be had in cheapest style of galvanized iron, but they are better when made with copper interior.

Fig. 282 shows a Geyser set up upon a stool at the end of a bath, the cold water for the Geyser coming in from the crane above it.

Fig. 283 is a more elaborate and expensive style of Geyser for heating water up to 212° Fahr., for clubs, hotels, railway stations, &c. It is said to raise half-a-gallon of water to 212° in one minute, and to give a hot bath of 40 gallons at 100° in 8 minutes.

There are other Geysers or hot-water heaters in this style in the market, such as Ewart's, &c.

Where a Geyser or hot-water heater is used it is a good and wise precaution to see that the bath-room, &c., when it is used is well ventilated, so as to carry off any bad air or dangerous fumes from the burnt gas.*

Deaths have occurred from the neglect of this precaution to persons when in the act of taking a hot bath where the water was warmed by one of these gas-heating appliances.

Before concluding this Chapter, I may give a sketch or horizontal plan of how an architect friend caused the waste-pipe leading from the bottom of the bath to the rod-pipe to be put in so as to allow for expansion especially when said waste-pipe is long. The sketch Fig. 284 has the appearance of a lead trap lying on its side.

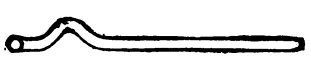


Fig. 284.

* See page 199 of the Author's text-book on Ventilation, No. 271 of Weales' Series, in this relation.

## CHAPTER XVIII.

### Hot-Water Supply, Cisterns for Hot and Cold Water, also Hot-Water Tanks.

Having so far treated upon baths, we would here say a few words about the hot and cold-water cisterns, &c., in connection with them. Fig. 285 shows a style that was much in use for many years, W being the hot-water cistern and X the cold-water one.

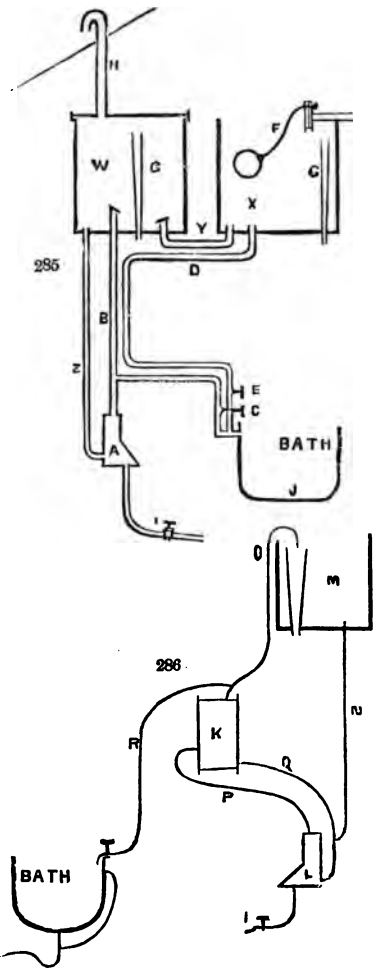
The hot cistern would be a little taller or higher than the cold one, because the hot water is lighter than the cold. Y, Fig. 285, is 1-in. or 1½-in. lead pipe leading the water from X into W. Upon the top of Y, in hot cistern W, a light-hinged valve is soldered, which allows the cold water from X to pass into W, but prevents the water from W passing back into X. Z is ¾-in. 9 lb. lead pipe leading the water down to the boiler A. B is 12 lb. 1-in. lead pipe leading hot water up from boiler.* Upon the top of hot pipe B a light-hinged valve is placed, which shuts when the hot-water crane C is opened, thereby causing the hot water to be drawn from the boiler. D is cold supply-pipe to bath and E cold-water crane.

These two cranes in this case are two pillared screw-down stop-cocks, with round or octagon knobs, or better still, four-pronged knobs for handles. Lambert's cranes are largely used for these, but the great fault with Lambert's stop and bib-cranes is that the working screws so often give way, and few things are more common in many plumbers' accounts, than "new bush and screw for Lam-

* *Of course these sizes* are not compulsory, for both pipes may be *only ¾ in. internal diameter*, or both may be 1 in., or even more if *wished or necessary*; the flow of the hot water is often more satisfactory, however, when the outlet pipe from the boiler is larger.

bert's crane." It is surely within the power of our brass-founders to remedy this, and so to make this "bush and screw" that it will stand better and not be so easily overhauled as it so often is.

For cold water especially, and for strong pressure, I know of no bib-cranes which give more satisfaction than Guest and Chrimes' style of screw-down ones. It is a rare thing to see their screws overhauled. For ball-cranes, however, Lambert's patent seems to be the general favourite. A common fault with them is to put on too small balls at first, which have afterwards to be taken off and larger ones put on; better therefore to put on good-sized balls at first. With a good pressure, a $\frac{5}{8}$-in. Lambert's ball-crane with a 7-in. tinned-copper ball, works well.* F, Fig. 285, is ball-crane, and G G overflow pipes. In reference to these




Figs. 285 and 286.

* There are many other high-pressure ball-cocks; some with too small and too light balls are a nuisance by the rattling noise they mak

overflow pipes, and also the steam-pipe H, it must be seen that they are so put in as that there will be no chance of bad air coming back or up through them to contaminate the water in the cisterns. In the case of the hot cistern W, Fig. 285, which is covered in on the top, if bad air gets in either through H or G it accumulates and in time taints the water very badly.

I had pretty strong evidence of this some time ago—viz. at the beginning of June, 1875—when requested by Dr. Fergus to examine a number of the better class of houses at Crosshill, near Glasgow (the scene of the late typhoid fever epidemic), and in one, the first I think we went into, complaint was made of the bad quality of the hot water. A tumblerful was drawn off and smelt, when the odour given off was found to be quite fetid. Upon examination, this was discovered to be caused by the steam-pipe of the hot-water cistern being led back, or connected into the side of the water-closet soil-pipe, instead of being carried out directly to the outer air.

One curious point in connection with this case was that the bad plan of connecting the steam-pipe to the soil-pipe necessitated a great deal of work and considerable expense, whereas, had the proper plan been adopted of carrying up the steam-pipe to the outer air, it might have been done at one-third of the expense. This, and various other matters which have turned up within my own practice, force me to observe that all interested in sanitary matters must get a better knowledge of the plumber's work and drainage of our houses than many as yet possess.

Of course they may retort upon me—And where can we get it? To which I feel bound to answer that it is difficult to get. At the same time, however, I may, perhaps, be excused for here adding that a careful perusal of this little treatise may possibly help to supply that knowledge at least in part.*

To come back to Fig. 285, we see that the steam-pipe H is correct as it goes right up through the roof. Had the cistern W, however, been a long way from the roof but near

* *Since the foregoing twelve lines were published in the first edition of this book, in 1876, much has been done to impart more light, to the plumbers and others interested, upon these subjects. Technical journals have been published, and technical classes for the special instruction of plumbers instituted, while several treatises, by various authors, now exist dealing with the work of the plumber.*

a back wall say, then all that was necessary would be that a hole should be cut through the back wall, about a foot or so higher than the cistern, and the steam-pipe H carried up and out through that hole. As W is a cistern and not a close tank, no water, but only steam, can come out at the pipe H.

In the case of Fig. 286, which has a close pressure tank K, both steam and water may come out at the steam or expansion pipe O, consequently the outlet of O must be so placed as that there will be no danger of any person being burnt when the water happens to boil. I may here caution servants and even mothers not to allow either laziness or thoughtlessness to cause them to use the water from the boiler instead of the kettle in preparing the children's food. What is good enough for washing may not be quite so good or safe for drinking.

In regard to the overflow-pipe G, in the hot cistern W, Fig. 285, it might be kept a little higher than the cold overflow and led out from the bottom of the hot cistern and up through the bottom of the cold one in a similar manner to the way the pipe Y is put in. Or it might be led out to the outer air as most suitable.

The hot-water cistern W, Fig. 285, as stated above, is covered in, and it has a 2-in. lead or zinc steam-pipe led out to the roof. The top covering of this cistern, which may be of wood, is so put on as to be readily movable, at least in part. I, Fig. 285, is 12 lb. 1-in. lead pipe, with 1-in. ground stop-cock on it for cleansing or scouring out the boiler; the outlet of this 1-in. pipe, I, must either lead into a drain trap or waste-pipe, or else be discharged above ground where it can do no harm, just as may be most suitable in the circumstances. J, Fig. 285, is cross section of bath, the waste-pipes, &c., of which may be fitted up either as those in Fig. 253, or in some of the other ways shown.

When setting in the boiler A, Fig. 285, the end from which hot-water pipe is led out should, if anything, be kept the highest, and the hot pipe B, or rather its coupling, should not project down into the boiler, or if it does project down a little, a slit should be filed out on each side of it. I mention this, because when these precautions are neglected, and the steam thereby prevented from having free exit up the hot pipe, disagreeable noises are often caused when the boiler gets heated up.

In regard to the hot and cold pipes from and to the boiler, they should not be allowed to sink, or to "bag" down anywhere, but should have as regular an inclination in every part of their course as circumstances will allow; lowest next boiler, and ascending upwards from it. When being carried horizontally in any part of their course, the pipes should then be laid on a board or boards, properly supported or fixed, said boards having as much of a dip or inclination down towards the boiler as possible. This helps to prevent explosions, as it allows the heated water and any steam to rise up the pipe easily and naturally.

The style shown in Fig. 285, if carried out as I have stated, is pretty safe in frosty weather, for if fire be kept on, the boiler pipes Z and B are both kept warm throughout their entire length from the movement of the water. For greater safety, however, it is well to wrap up pipes to and from boiler with felt (in fact as a defence from frost this is good for all pipes). To ascertain if the boiler is being supplied properly, open the hot crane at the kitchen sink or bath, and let it run a minute or so. This should always be done after the cleansing-cock I, Fig. 285, has been used (due time, five or ten minutes or so, being allowed for the boiler to fill up), for no fire should be on when the boiler is empty, and no water should be allowed to enter an empty boiler when the boiler is hot.

As regards the site of baths in houses, they should never be fitted up, as we may often see them, right above the principal rooms, for as accidents will happen, and pipes will burst or overflow occasionally from various causes, the damage done in such cases is sometimes great.

In Fig. 286, no hot cistern is used, but instead a good malleable iron or copper intermediate close tank K, is used. Many of these have been put up of late years and given great satisfaction. The tank K is generally placed in a corner of the kitchen as near the boiler L as convenient; it is supported on a strong wooden shelf. If in a one-story house it is sometimes placed in the garret or loft; this latter plan, however, tends to have an injurious effect upon the regular flow of the water, as air is apt to get into the pipe R *from* O, *owing to the* pipe P not being able to supply the *water quicker, or at least* as quickly, as it is drawn off *through* R. *If the* pipe P and the brass couplings at each *end of it, and also the* brass coupling inserted into the top

of K and the lower part of O, as far at least as R branches off, are all of 1-in. bore while R is only of ¾-in. bore, then, perhaps, the supply may come in through P and up the lower part of O as quickly as R is able to draw it off. The higher, however, that the cistern M is above the tank K, the less chance there is of air getting into R and interrupting the steady full flow of the water. Of course, to get the full benefit of M being higher than K, the pipe R must branch off as near the top of K as possible.

In case it should be asked, why not branch R from off the side of P, I answer that that is not done for several reasons: one reason being that we want to get the benefit of the whole of the contents of K and L as warm as possible, and another reason is, that by always leaving K full of water, greater safety is insured to the inmates and less danger of L drying up during any scarcity of water.* Of course the sludge cock I, Fig. 286, empties everything, but it should only be opened when there is plenty of water, and by some one who understands what he or she is doing.

In Fig. 286, there are only three brass couplings on the boiler, but in some cases four couplings are used, as in Fig. 287; generally, however, three are sufficient, especially if the outlet coupling from off the top is larger than the inlet near the bottom. In Fig. 286 the boiler L is shown with a "sludge," or cleansing-cock, I. Where a good job is wanted a coupling may be put into the bottom of the tank K with the necessary pipe and sludge-cock, so as to cleanse out the tank also when wished.

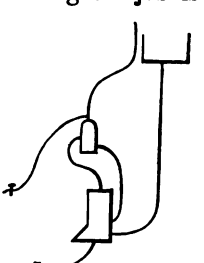


Fig. 287.

In Figs. 285, 286, 287—supposing the baths to be set upon a higher level than the kitchen boiler—when the bath-crane is at some distance from the upright hot pipe, as at J, Fig. 297, it follows that when the hot-crane has been shut for some time, the water lying in the *branch*-pipe, between the hot-cock and the perpendicular pipe, gets quite cold, so that when the hot-crane is opened this cold water has first to be all run off before the hot comes. To obviate that, where it is wished *and the extra expense is allowed*, carry a ½-in. pipe P

* *In one case I had to put* R 3 in. from top of K, as M was only 1 ft. *above* K, *as shown in Fig. 294.*

from close behind or below the hot-cock with a downward inclination back into the cold-water supply to boiler, or the cold circulating-pipe between the boiler and the tank, as shown in Fig. 288, so as to allow of a circulation of the water. If no bagging is permitted with any of the horizontal or other branch-pipes, a small inclination if regular may serve.

In Fig. 288, C is the cold-water cistern; D the down supply to the boiler; B is the boiler of copper or malleable iron, preferably copper; T is the hot-water tank, preferably copper; U is the main hot-water and steam or blow-off pipe; H is the hot-water crane, at the bath say; P is the small (say ½-in.) return circulating-pipe branching at its bottom into the cold circulating-pipe between the boiler and the tank; S is the sludge-cock to empty the boiler, where the water running off can be seen; J is the draw-off cock at the sink. There may also be a brass or copper warming or towel rail W, through which the hot water circulates when the stopcock V is open. F is air-pipe into rising main U. Sometimes it may be more convenient to put in a special air-pipe E, or only an air stop-cock. R is return circulating-pipe; K is a ¾-in. dead-weight safety-valve.

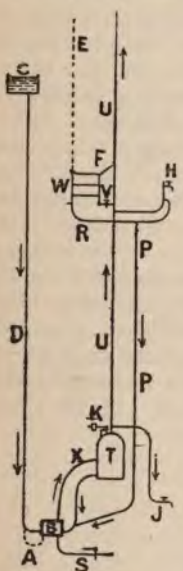


Fig. 288.

In Fig. 289 we see a specimen of the "How *not* to do it" style of work. Firstly, on the cold-water supply to the boiler a trap T is placed, in order, as has been stated, to prevent the hot water from the boiler getting up into the cold-water cistern C, but it has been forgotten that air may collect at the top of the outer end of the trap, and so prevent the free flow of the water to the boiler. If a trap is wanted on the cold-supply pipe it should be down at the boiler, so that the air may get freely out at either *end of it.* *See dotted* line A Fig. 288, also A Fig. 290.

*Another fault is that* the boiler is highest at the end B, *and so allows the steam* to collect there and cause noises. *The hot-pipe from* the boiler to the tank is too high at H,

the bend at H being higher than the junction at the tank, and so again preventing free exit to the steam. By connecting the draw-off pipe for the sink-crane S, as shown, the cylinder F can be emptied, and so the explosion or destruction of the boiler made all the more easy.

When the supply-pipe to the boiler is bent down below the boiler, as shown at A, Fig. 290, the lowest part at A is best not to be below the kitchen floor, or where the water, if the pipe burst, might leak or run away unseen, because if so, and the cold-water supply-cistern got emptied through the water being off the main temporarily, then the leak or burst at A might empty the boiler unknown to any one, and, if a good fire happened to be on, the boiler might soon get red-hot, and we may have either an explosion or damage to the boiler or its pipes.*

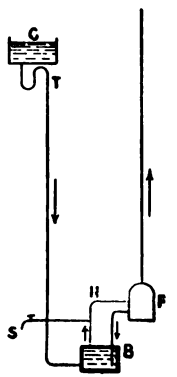


Fig. 289.

In Fig. 291, although the boiler be properly set, with the end where the hot outlet-pipe or coupling H is highest, yet as the coupling H is made to project down below the top of the inside of the boiler the steam cannot get freely away, and so there are noises and other bad effects. By cutting or filing out V-shaped notches out of the bottom of the brass

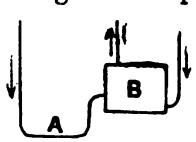


Fig. 290.

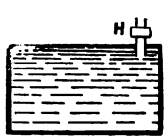


Fig. 291.

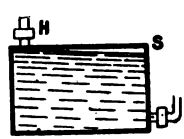


Fig. 292.

coupling where it projects, the steam may then get away, and the evil be cured.

In Fig. 292, although the coupling is all right, the boiler

* Should the sludge pipe be below the floor and leak or burst, then the people may get warning so far by the water not warming, but with the burst at A on cold supply as per Fig. 290, no such warning may be given. The fizzing or hissing noise from a burst pipe is an intimation of something wrong. Cold water running into a red-hot boiler need not burst it if the expansion pipe is not frozen up and all clear, or a proper safety valve is fixed near the boiler or the tank, as at Fig. 288, or nearer the boiler still, on pipe X, to allow exit to steam.

has been badly set, as its higher end is away from the hot coupling H, so that the steam collects at the end S, and noises are the result. In this case the remedy is to reset the boiler, and so that the end at H, instead of being lower than the end S, may be about one-eighth of an inch or so higher.

Fig. 293 shows a boot-boiler improperly set. It is too high at A, and allows the steam to collect at both A and B. Instead of the front of the sole at C being higher than D, the boiler should be so set as that the back part at D will be either level with C or one-sixteenth of an inch higher than C.

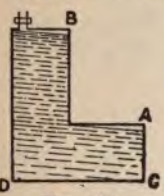


Fig. 293.

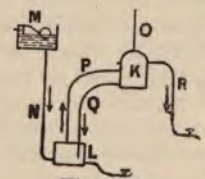


Fig. 294.

Fig. 294 shows the cold-water cistern M placed only slightly above, or nearly level, with the top of the hot-water cylinder K. In this case, to join the top end of the pipe R into the expansion or blow-off pipe O, close above the cylinder, as in Figs. 286 or 287, would give unsatisfactory results, as stated on pages 168, 169, on account of want of pressure and air getting into the pipe R. By joining the top end of the pipe R into the side of the cylinder K 3 in. or 4 in. from the top of the cylinder we get both 6 in. or so more pressure and also the benefit of the body of hot water in this 4 in. Then while the warm water is being run off at the crane C, water is flowing into the cylinder K from the pipes P and Q, so that a considerable quantity of water may be run off at C before the water in K is lowered sufficiently to allow air to get into the top of R. In fact, in practice, so long as there is plenty of water in the cistern M, the crane C may be used a hundred times before indication of air getting in at top of R—and interrupting the full flow of the water—may be temporarily noticed.

In thousands of our houses the water-pipes lie quite exposed in our garrets, &c. Now if people would order or allow their plumbers, &c., to wrap up their pipes and cover in their cisterns, the frost would not interfere with the *water-supply in the* disagreeable manner it so often does.*

* *In many cases of late* I have used heavy flannel belt, cut into *strips and tied on with thin* copper wire, to wrap the water-supply *pipes, both hot and cold, going* through the house, and in some cases *ave labelled them all separately* in each flat.

The hot-pipe O, Fig. 286, when bent over the cistern, instead of being carried out to the roof, can be bent down into the overflow-pipe of the cistern, so that should the water in the boiler begin to boil up the hot-pipe, it does not dirty the water in the cistern. N, Fig. 286, is the cold supply to the kitchen boiler; P and Q, Fig. 286, are the hot and cold circulating-pipes between tank and boiler, while R is the hot-pipe leading to bath and elsewhere where needed.

In regard to cranes, I may here add that where the pressure or height of water-supply above crane is only about ten feet or less, then the best crane to use, and the one which gives most satisfaction in that case, is a gun-metal, or good brass, ground cock, requiring only a quarter turn to open or shut.

In many cases, with only a few feet of pressure, the valve of a screw-down crane often refuses to open if kept shut for a day or two, the valve having stuck to its seat, there being too little pressure to open it. I could mention various places where this is the case, the plumber or architect having made the mistake I refer to.

Fig. 295 is style of brass couplings for boiler, &c., the upper half (which may be also had bent in place of straight) D, being soldered or connected to pipe, and lower half E, screwed into boiler; the internal diameter is generally either ¾ in. or 1 in., but for larger pipes larger couplings may be used. Fig. 296 shows section of brass light-hinged valve, used on hot-pipe and in cistern, in Fig. 295 its internal diameter at bottom is about 1 in.

Fig. 295.

Fig. 297 is simplest style of supplying hot water, no intermediate tank or hot cistern being used. The supply of hot water to house is, of course, less in this case. F, Fig. 297, is cold-water cistern, G boiler, H supply to boiler; I I is hot water and expansion or blow-off pipe out to roof; J is hot water supply-pipe to bath. In all the above boilers I have shown the cold-water pipe entering at, or near, the bottom, but it may also enter at the top if desired, a piece of copper tube being attached to the under side of the coupling, as shown in Fig. 298. This plan does not make such a good job, however.

Fig. 296.

Solid-drawn copper pipes have been much used of late for the hot-water supply-pipes; hard soldered copper pipes are also much used, being cheaper than the solid-drawn pipes. The thickness of copper is about $\frac{1}{8}$ in. and under; the internal diameter of pipe may be either $\frac{1}{2}$ in., $\frac{3}{4}$ in., or 1 in., or even more if required. They can be had tinned both outside and inside, which is preferable; they are joined with strong brass couplings screwed inside, the ends of pipes being screwed outside. Cast brass Tees are used for the branches; all the joints, where the brass couplings are screwed on to the copper pipes, are soldered—at the junction of the copper pipe with the butt end of the brass coupling—in addition to the screwing. Before the coupling is screwed on, however, both the screwed end of the pipe and the inside screw of the coupling should be tinned if a sure job is desired. In fact, the half of each coupling should be completely fixed on to the end of pipe before the pipe is laid into its place.

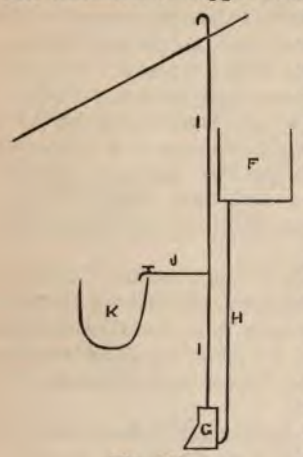


Fig. 297.

As a help to prevent explosions, safety valves have been coming into use lately in connection with kitchen boilers. In fact, it is curious how they have not been made compulsory long ago. They are especially necessary for boilers such as in Fig. 297, which have no intermediate tank, but useful also in Fig. 286 style, which have such tank. Yet in all cases a safety valve would be a great advantage placed either on the tank or on the expansion pipe between the boiler and the tank, and be especially serviceable in frosty weather, when it should be examined now and then, to see if it is in working order and the valve not stuck.* These valves are made by

Fig. 298.

* I have one in my own house, above the kitchen mantelpiece, and *occasionally slacken it* and draw a cupful of water to see if it is working *and not stuck*. Boilers do not explode if water runs into them

various parties in different parts of the kingdom, *e.g.*, by J. Warner and Sons, J. G. Stidder & Co., and J. Tylor and Sons, London; John Mills, Leeds; Fell & Co., Wolverhampton; Guest & Chrimes, Rotherham, &c.

Recently I have put on a weighted *lever* safety-valve upon the top of the hot-water tank in some cases.

Fig. 299 is vertical section of the dead-weight safety-valve made by Messrs. Alex. Turnbull & Co., safety-valve manufacturers, Bishopbriggs, near Glasgow. V is the valve resting on the top of the pipe P, W W W W are a series of lead or other metal weights to load the valve to suit the required pressure or head of water.

Fig. 299.

The pressure of the atmosphere at the sea-level is about 15 lbs. to the square inch, equal to a column of water 34 feet high. So to balance a head of water 34 feet higher than the site of the valve, the valve requires to be loaded to 15 lbs. on the square inch, or fully that to allow a working margin.

At the sea-level water boils at a temperature of 212° Fahr., but high up upon a mountain it boils at much less. In a vacuum the water will boil at 90°, or less than blood heat. This would be of little service for cooking purposes.

In a kitchen boiler supplied from a cistern 42 feet higher than itself—which gives 18½ lbs. per square-inch of pressure—the temperature at which the water boils is 254° Fahr., or 42° higher than the boiling point of the water in an open vessel in the same position, as, say, in the tea-kettle. Now remembering that steam can occupy 1,700 times the space that water does, it follows that the sudden rupture of a boiler either full of water, or with a considerable quantity of water in it heated up to 254°, or higher,* is bound to do immense damage, owing to the vast amount of energy suddenly set free. The value of the safety-valve to prevent

when red-hot unless the blow-off or expansion-pipe is frozen or choked up in some way which prevents the free outlet of the steam. There should be no bagging down in an expansion-pipe, and it should be protected from frost as much as possible.

* If both the inlet and outlet pipes were either frozen up, choked, or stopped up, then the temperature of the water might or would rise much higher than 254°—according to the strength of the boiler and its connections—before explosion.

rupture of the boiler under pressure, or dangerous explosions, is therefore manifest.

During the long and severe frost of January and February, 1895, when the cold registered for a long time not only considerably below freezing, but repeatedly went down to several degrees below zero, the question often arose, How can we keep our kitchen-range burning while our water-pipes are frozen up?

I solved it in some cases as per Fig. 300. The cold supply-pipe S to the boiler was corked up inside the cistern at C. The hot expansion or blow-off pipe E was then uncoupled from the top of the hot-water tank T, as shown at H. Now with the fire on constantly (it may be damped down at night) there will always be warm water in the boiler and in the tank, cold water being poured into the tank through the open coupling H by means of a jug or filler once or oftener every day, as needed to keep the tank full, or nearly so. Should the water boil the steam will come out at the open coupling H as out of the spout of the tea-kettle.

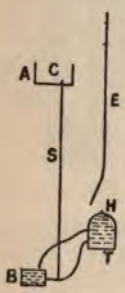


Fig. 300.

If it is desired to draw off part of the warm water in the tank, this could be done occasionally by using a few feet—say 4 ft. or so—of ⅜-in. or ½-in. gas-pipe bent to act as a siphon, and with or without a crane upon it. When the hot water wished was drawn off its place would have to be immediately supplied by cold water put in.

In this connection, as a provision against frost eventualities, it might be a good thing to put in a 1-in. trap screw—brass—on the top of the tank, and another on side half way down (into which latter a crane could be screwed if wished during frost). If foregoing were done when the tank was being supplied it would prevent necessity of uncoupling the expansion-pipe or using a siphon.

In houses fitted up with a hot-water cistern (not a close tank) and a small boiler at back of kitchen fire for the supply of hot water to the house, it is well, while drawing the hot water direct from the boiler, as already explained in *connection with Fig.* 285, that the water going into the *boiler should be as* warm as possible. To effect this, cause *the water going into* the boiler to come from the top of the *body of water in the* hot cistern, where the water is warmest,

and to do this, on supply-pipe to boiler place a crane with long piece of ¾-in. brass or copper tube attached to it, and with float-ball, as shown in Fig. 301. The highest end of this brass tube should be kept 2 in. or 3 in. below the surface of the water. In order to prevent the crane sticking, use a ground one, and upon its key fix a brass washer as at U, Fig. 301A, then file down the key so that it cannot stick fast in the barrel. Any other plan, however, which answers the purpose, and causes the hot water from the top of the hot-cistern to enter the boiler, may be adopted.

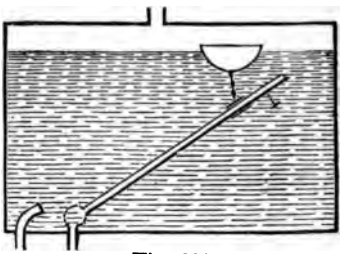


Fig. 301.

Fig. 301B is sketch of a back or side open-top or low-pressure boiler B, supplied from a cistern C upon the same

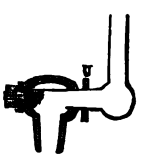



Fig. 301A.

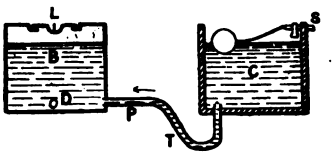



Fig. 301B.

level. The connecting-pipe P from the cistern to the boiler is bent down into the form of a trap to prevent the warm water from the boiler going back into the cistern. D indicates a draw-off crane for the warm water. The cistern is better to have an overflow, and a stop-crane may be put on at S, behind or below the ball-crane, to shut off the water easily when wished.

## CHAPTER XIX.

### WASH-HAND BASINS.

WE come now to wash-hand basins; these may be fitted up in many styles, from the simple plug and socket one shown in Fig. 302, to the most elaborately fitted up cabinet stands. In Fig. 302, W is the wash-hand basin, X is ½-in. pillared stop-crane, Y is 2-in. lead siphon trap, Z is safe-pipe with overflow of basin led into it.* A is brass socket-grating with brass plug. This brass plug has brass chain attached, and is taken out and put in with the hand.

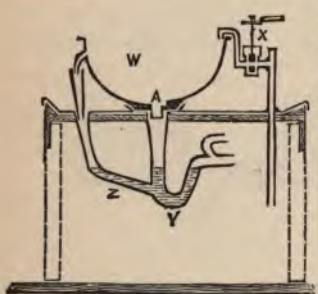


Fig. 302.

The bottom of the socket-grating at A is perforated with holes about ⅜ in. in diameter. In addition to these holes in the bottom it is a great assistance to the speedy outflow of the water to bore half-a-dozen or more additional holes round the side of the socket-grating near the bottom. Instead of boring or casting holes in the bottom, the said bottom is sometimes taken out altogether and two pieces of brass wire put in crosswise. Of course the socket-grating may be cast in this latter style.

Fig. 302 shows perpendicular sectional view of wash-hand basin W, set and bedded with putty upon the top of the wooden wash-hand basin stool. The top of this stool (which is supported by four legs, one at each corner) is covered *with lead, say* 4 lbs. to the square foot, and the top of *siphon-trap* Y, *being* carried up through the hole cut for it

* *Some plumbers prefer the trap and waste-pipe to be only* 1¼ *in. or less in bore.*

in the top of the stool, is soldered to lead safe. The supply-pipe to water-crane X, where it passes up through stool, is also soldered to lead safe, thereby helping to keep the water-crane in its place. The general height from floor to top of basin is about 2 ft. 5 in.; but if put in so as to suit short or young people, the height may be a good deal less.

This simple style of fitting in wash-hand basin corresponds with that of bath, as shown in Fig. 241, Chapter XVII., but when so fitted up it was generally done to save expense, as, where the customer could afford it, the plug in the bottom of basin, as per A, Fig. 302, was dispensed with, and instead, the valve B, Fig. 303, with its more elaborate arrangement of pipes, adopted.*

In Fig. 303, B is ground brass valve, the diameter of which, or rather of its socket over all, is about $1\frac{3}{4}$ in.; C is 2-in. lead valve-pipe, made of 6 or 7 lb. sheet-lead, and is placed inside the 3-in. lead rod-pipe D. By keeping two-thirds of the circumference of the top of the valve-pipe C about 2 in. lower than the top of the rod-pipe D, the valve-pipe C thereby acts as its own overflow and as the overflow of the basin F, for as the water rises in basin F, by the law of fluids it also rises to a corresponding height in the valve-pipe C; but as the top of the valve-pipe C is 2 in. below the top of the rod-pipe D, which latter is level with top of basin, it follows that whenever the water begins to rise up in the basin higher than 2 in. from its top, it the water—immediately begins to flow away over the top of the valve-pipe C, which thus acts as a safety-pipe, at least so long as

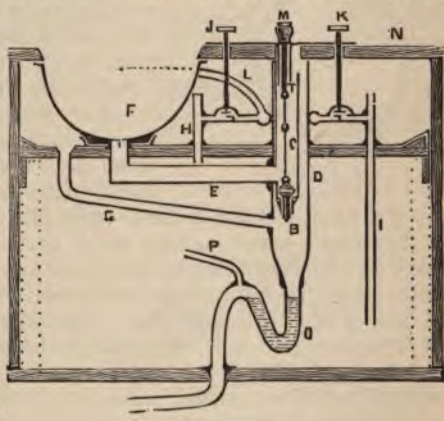


Fig. 303.

* *Fig. 302 style* is perhaps the most hygienic, however, see page 184, *especially if the* overflow pipe is distinct from the safe-pipe

the communication is left free between basin and valve-pipe. E is waste-pipe from basin; the soldered joint at end of E next the rod-pipe unites E, C, and D together as shown. F is the wash-hand basin, which may be either a plain white one or one with gold and colours, according to taste.

A very effective and chaste basin is one with three gold lines, each about ¼ in. broad, round it; one round top, one half-way down, and the third circle about 3 in. in diameter, round brass grating in bottom. G is 1½-in. lead safety-pipe for carrying away any water which may fall into the lead safe. H and I are the hot and cold supply-pipes of ½-in. bore, and, if of lead, either 6 lbs. or 7 lbs. per yard, according to pressure.

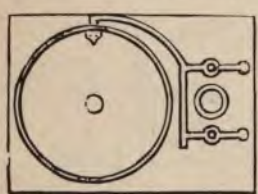


Fig. 304.

If the pressure on both hot and cold pipes is the same, the hot one is put in a pound per yard heavier than the cold pipe. J and K are the hot and cold pillared screw-down stop-cocks; size ½-in., with round or cross ebony or brass handles. The diameter of handles if round should be fully 1½ in., when less the crane is often difficult to shut.

For mere ornament very small handles may do, but for easy service a certain leverage is necessary. L is the supply-pipe leading water to basin, with small brass tube soldered to end of it, so that said brass tube bends over edge of basin. M is the knob, brass or otherwise, with lifter attached underneath to work the waste-valve at B. N is the wood or marble top of wash-hand basin, and it will be observed that underneath the waste-knob M, a hole is cut in it large enough to allow the waste-valve to be drawn up through it, so that the valve can be easily taken out to be examined or cleansed; this hole is not seen when the brass plate is put on. This brass plate, in this case, may be about 14 in. long by 3½ in. broad, but if the cranes were placed, as in Fig. 304, across the rod-pipe instead of end on to it, as in Fig. 303, then the two pillars of cranes being much nearer each other, the plate would be much shorter, say 9 in. long in place of 14 in.

*It is understood that* the pillars of the two cranes pass up *through holes in brass* plate just large enough to allow them *to do so. The two* cranes, J and K, at their outlets are *joined together by* a piece of lead pipe bent round the rod-

pipe, out of which goes the pipe L, Fig. 303, carrying water-supply to basin. O, Fig. 303, is a 2-in. or a 1½-in. lead siphon-trap, P is a 1-in. or larger pipe to ventilate the waste-pipe; it also serves to prevent the rush-off of the waste-water from emptying the siphon-trap.

Owing to the want of this ventilating pipe, or air-pipe, P, especially where the waste-pipe goes some distance horizontally and is rather small—say 1¾ in. in diameter internally in place of 2¼ in.—it often happens that the siphon-trap is emptied when the waste water is let off, whereupon bad air comes out into the apartment.

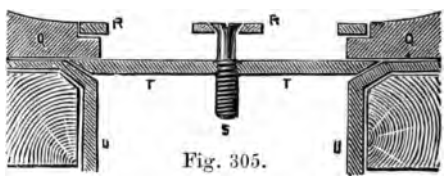


Fig. 305.

It is, therefore, highly necessary, especially where wash-hand basins are fitted up in or near bedrooms, to see that the waste-pipes are so put in as that there will always be plenty of water left in the siphon-trap. Inattention to this—especially where the waste-pipe had direct communication with the drain—has been the cause of disease and death entering many families, particularly of the higher and middle classes.*

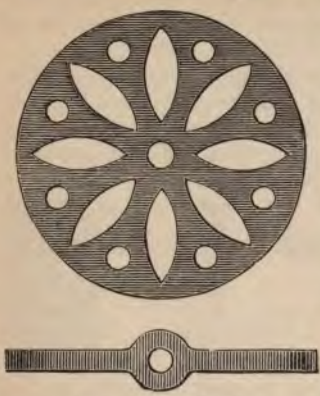
Where extra precaution is desired, instead of carrying the waste-pipe of the wash-hand basin or bath directly into the drain or soil-pipe, carry it down *per se* and let it discharge above the surface of the water in a ventilated siphon-trap. By this means any danger of bad air from the drains entering the bedroom through the wash-hand basin waste-pipe is prevented. A sketch of the principle here alluded to will be found farther on, in Chapter XXIX., under the heading "Scientific and Safe Water-closets," Fig. 410.

I may here add that when the waste-pipe from a wash-hand basin goes some distance horizontally, it does good in preventing the siphon-action to make the waste-pipe a size larger than the siphon-trap, *e.g.*, if the siphon-trap be 2 in. make the waste-pipe 2½ in.

For a good job, and especially where the inmates go from home for months together, the siphon-trap O, of the wash-

* *When near an outer wall the pipe* P, Fig. 303, *may be put through the wall, but connected, so as not to allow the cold air to play upon the water in the trap.*

hand basin should be so made as to hold a good depth of water. Were that depth in all about 8 in.—thereby giving about 6 in. of water-lock—due provision would be made for evaporation, and loss of water-lock prevented.



Figs. 306 and 307.

Instead of adopting this simple, yet effective course, I lately saw a proprietor going to the expense of putting on large 2-in. brass stop-cocks, which cocks were to be shut when the family went from home. Now not to speak of the probable difficulty of turning these large cocks after a time, there was the danger of water being poured into basins when cocks were shut, and as it could not get away a flooding might take place.*

Inside of bottom of wash-hand basin, F, Fig. 303, there is a round brass grating, about 2½ in. in diameter. This grating is held in its place by a brass screw, which passes down through its centre and goes into a small brass bar which passes across the top of the waste-pipe, and is soldered at each end to top of waste-pipe.

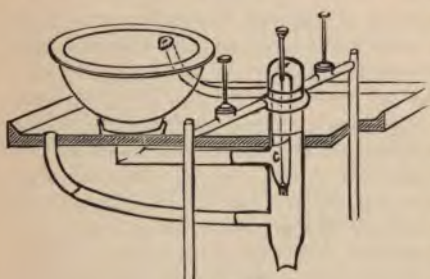


Fig. 308.

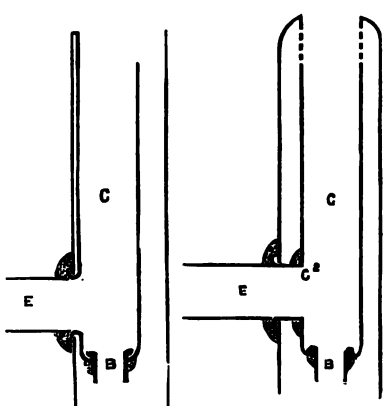
Fig. 305 shows perpendicular section of this brass grating bar and nail *in situ*, Q Q being bottom of basin; R R is brass grating (of which Fig. 306 *gives top view)*; S *is* brass-screwed nail, and T T brass bar *about ⅛ in. thick* (*Fig.* 307 gives top view of brass bar); U U

* *This actually took* place and the cocks were then ordered to be *taken off.* *Fig.* 311A shows another plan.

is top of the lead waste-pipe E, Fig. 303. Outside and around bottom of basin a strip of lead about 2 in. broad, or broader if wished, is soldered to safe, and being made to fit round bottom of basin it thereby helps to keep basin in its place when set.

Fig. 308 shows cranes and rod-pipe arranged alongside wash-hand basin, from back to front, in place of end on to basin, as in Fig. 303. The water in this case enters basin by mouth of lion's head, there being a horn at back of lion's head on outside of basin for supply-pipe to be attached to. The cranes need not necessarily be always put on as shown in Fig. 308, for by placing them as in Fig. 304, the pillars are brought nearer each other, while the arrangement is still kept up of the cranes and rod-pipe being alongside the basin.

In regard to the 2-in. valve-pipes C C, Fig. 303 and 308, there are two ways of fitting them in rod-pipes: Figs. 309 and 310 show these two ways. Fig. 309 is an enlarged view of that in Fig. 303.



Figs. 309 and 310.

In Fig. 309 the valve-pipe C is put in close to that side of rod-pipe to which the waste-pipe E, from the wash-hand basin is joined. In Fig. 310 the valve-pipe C is placed in the centre of the rod-pipe, and at $C^2$ a short piece of pipe is soldered on sufficient to pass out through side of rod-pipe and be flanged back about $\frac{3}{8}$ in. B B, Figs. 309 and 310, are the brass sockets of the two waste-valves soldered to the bottom of the valve-pipes. Further verbal explanation is unnecessary, as the two drawings explain themselves.

In Figs. 309 and 310 the brass valve-seat B is shown suspended as it were from or simply attached or soldered *to the bottom* of the valve-pipe C. Especially where hot *water goes down* the pipe the valve-seat B is sometimes *knocked away* from the bottom of the pipe C. As a pre

ventive of this, a short piece of pipe is sometimes put in below the valve-seat, as shown in Fig. 311, with slits in it to allow passage for the overflow water. A trap screw may be put on at T in case of chokage.

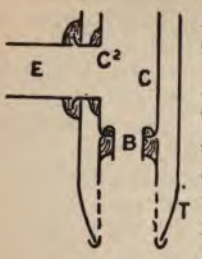


Fig. 311.

In wash-basins, baths, &c., with rod-pipes, as in Figs. 303 and 308, when the basin is empty and whether the waste-valve is open or shut, a current of air often will be found passing down the pipe C, along E, and up through the grating of the basin, so that if pipes C and E are dirty inside a slight smell may be felt by a sensitive person at the basin. To stop this, especially if in a bedroom at night, first run off a gallon or two of clean water, then put the valve down, and leave a few inches of clean water in the basin all night. Of course this would do no good against smell from the waste-pipe *beyond* the trap: the trap and pipe must do their duty as regards that.

In Fig. 303 the safe-pipe G might have been much shorter than those shown by being connected to the safe under crane K, say, while its lower end instead of being soldered, as shown, to the 3-in. pipe some distance above the surface of the water in the trap, might have been soldered into the side of the water-trap 2 in. or more below the top of the water, down, say, about "O." Doing so prevents air passing up the pipe G while the basin is being emptied. It is useful to solder on a brass trap-screw at the bottom of the trap O, Fig. 303.

Fig. 311A shows trap designed by me to prevent passage of bad air through trap should the trap burst and let the water out. A is a ball (or it may be a half-ball, with guide-pin) of india-rubber or wood, &c., resting upon the outlet end of the trap. The outgoing waste water pushes up this ball, but it falls back again when the water stops running. B is a trap-screw for access to the ball. C is another trap-screw for the trap. G indicates ventilating pipe.

*Fig. 311A.*

*In the next* chapter we proceed to treat upon cabinet-*stands and different* ways of fitting up from the above.

## CHAPTER XX.

### Cabinet-Stands, and Lavatories.

The earthenware wash-hand basins treated upon in Chapter XIX. were all circular, with a simple rim at the top, but as will be seen from the cabinet-stands we are now to speak of, while the hollow in the centre forming the bowl or water receptacle may be the same, the simple 1½ in. rim is now transposed into a large square top, with soap and brush-holders, all together forming one piece of earthenware, as per Fig. 312.*

Fig. 312.

In some cases the shape of the top of the cabinet-stand, in place of being square may be either angular or have rounded front, as shown by Figs. 313 and 314. They are also made with back and sides as per Fig. 315. Having settled upon the shape of and got his cabinet-stand,

Fig. 313.

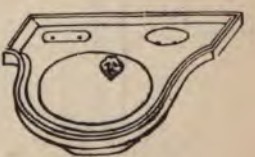


Fig. 314.

which we will suppose is a square one, as shown in Fig. 312, the plumber has next to get the wooden stool upon

* *Since this* was published, in 1876 edition, the shape of the bowl *has often been of* an oval form, as illustrated farther on.

which it is to rest. The style of this stool, however, depends upon the way in which it is intended to finish the wood-work of the cabinet-stand.

If, *e.g.*, the wood lining were intended to be put round the front and sides of stand, just as in Fig. 303, then the stool in this case may have four legs, two at back and two at front, just as in Fig. 303. We will, however, suppose that the stand is not to be lined in down to the ground, or close to it, all the way round, in which case the wooden stool which is to support the cabinet-stand, as also the necessary cranes and pipes, &c., will only have two legs, one at each back corner, as per Fig. 316.

Fig. 315.

In looking at Fig. 316 it will be at once seen that such a stool, with only two legs, could not stand of itself, and far less could it support such a wash-basin as that of Fig. 312; consequently, while the plumber is working at it, and before the stool is fixed in its place, a temporary leg has to be put in at its front.

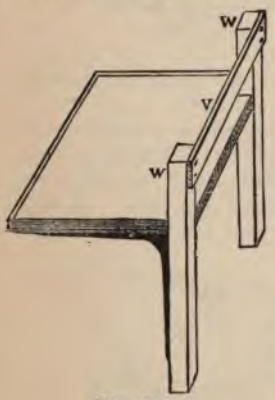



Fig. 316.

When fitted up, the stool is fixed in its place by means of the top bar V, Fig. 316, which top bar is a piece of wood from about 2 ft. 6 in. to about 3 ft. long, as the case may be, and 4 in. broad and 1 in. thick. This top bar is checked into the back of the two back legs, as shown at W W, Fig. 316—or rather as intended to be shown, for the engraving has the bar V nailed against the back legs instead of checked into them—and firmly fixed by means of screws. The stool being set up in its place against the wall, this top bar V, Fig. 316, is then firmly fixed to another *wooden bar of the* same size which has been firmly fixed to *the wall, as per* X, *Fig.* 317.

The wall in Fig. 317 being supposed to be either a brick or a stone one covered with plaster, the wooden bar X is shown flush with plaster, the plaster being cut out to allow it to be so. When, therefore, the bar X, Fig. 317, is firmly fixed, and the bar V firmly fixed to X, then a considerable weight may be quite safely placed on the seat of the stool, more especially as this seat itself is supported by two iron brackets, as shown at Y, Fig. 316. The length of each arm of these iron brackets may be, say from 14 in. to 18 in., one arm being firmly screwed to back leg of stool, and the other arm supporting a slip or bar of wood as long as the breath of the top of the stool extends outwards.

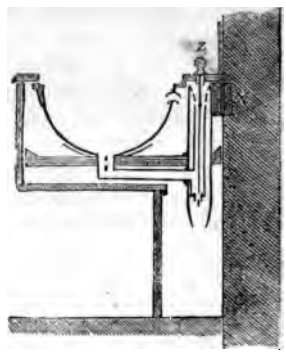


Fig. 317.

This slip of wood may therefore be about 2 ft. long by 4 in. broad and ¾ in. thick. Screws about 1½ in. long, put in near Y, Fig. 316, will therefore fix iron bracket, wood slip, and seat of stool all together. Around the outer top edge of the stool wood doubling about 1 in. high and 1½ in. broad is placed for the lead safe. The height from floor to the top of the back legs will, in this case, be about 2ft. 5 in., the top of wooden leg being level with the top of cabinet-stand.

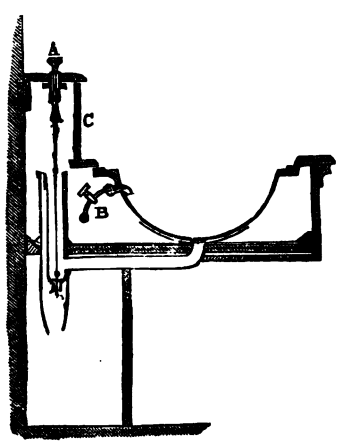


Fig. 318.

In some cases, however, as in Figs. 318 and 319, the height of the back legs will be above 3 ft., extending up about 9 in. or so above the top of cabinet-stand. This extra height is to suit a difference in the style of fitting up pipes and handles, and in the arrangement of the marble or mahe-

gany. Fig. 317 shows section from back to front of a simple style of finishing either the marble or the mahogany at top, while the supply and waste for stand are regulated by three pull-up knobs, one of which, the waste, is shown at z, Fig. 317.

In Fig. 318 another style is shown, the knobs resting on the marble shelf which goes along at the back of the stand about 9 in. above the top of the basin, as shown at A, Fig. 318.

In cases where there is a strong pressure of water on supply-pipe to basin this pressure may be regulated by putting on a good ⅜-in. or ½-in. gas stop-cock, as at B, Fig. 318. This prevents the incoming water from rushing up over basin and wetting all and sundry near it. If, however, it is only the pressure on cold-water pipe that is extra strong, then the small cock should be put on the pipe coming from cold cock.

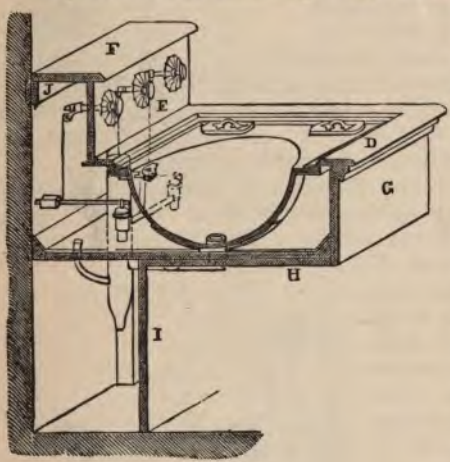


Fig. 319.

In fitting up the marble at Fig. 318, the front piece at C should be so fitted as to come out easily when wished without moving the top, so that the plumber may have easy access to arrange or repair his fittings. The neglect of this (which should be provided for as far as possible in all cases) is often the cause of unnecessary expense and annoyance afterwards.

Fig. 319 gives an idea of the large square cabinet-stand shown in Fig. 312, fitted up with hot and cold water, the cranes and waste-valve being worked by means of pull-out *knobs and pulleys.* In this case they are arranged from *left to right as hot,* waste, and cold, the particular words, "*HOT,*" "*WASTE,*" and "COLD," being engraved, or otherwise marked, each on its own appropriate knob.

In other cases, if wished, the arrangement may be hot, cold, and waste; the rod-pipe in this latter case being put to the one side, and the cold, if off the main with an extra strong pressure, may have its knob made to turn round, being fixed on to the spindle of a screw-down stop-cock, in the place of pulling out like the other two. In order to get a proper hold of it, this cold knob may in this case be also made larger than the other two, and, owing to its being in the centre, this extra size will be no objection. The outer rim of all such knobs for screw-down cranes ought to be properly roughened or indented, so that a firm hold may be got of them. In place of a round knob, however, some prefer a four-pronged handle, as per Fig 349A, for the screw-down stop-cocks.

In Fig. 319 we see three pieces of marble, D being the large square horizontal top piece, with large hole in its centre, which appears to rest on cabinet-stand. E is perpendicular breast-piece which rests on D as shown, and to which the back-check lifters are attached, and through which the pulls work. A small piece of marble is also required at each end of E, being put on at right angles thereto. F is an oblong horizontal top-piece of marble, covering in space between E and the wall. This top-piece F should be readily movable at pleasure, so as to allow the plumber to get at fittings. The front piece E should also be movable when required. The plumber also on his part ought so to arrange his cranes, &c., in position, or with couplings, as may be necessary, so that repairs may be easily made.

If the expense be no objection, a ½-in. stuffing stop-cock may be put on underneath the basin stand, *i.e.*, between it and the floor, upon both the hot and cold supply-pipes, so that the water could be easily turned off the basin fittings when necessary without interfering with anything else. The hole in lever handle of said stuffing stop-cock should, in this case, be of an oblong square shape, and the top of pillar, which goes into it, made to fit, and of the same shape, so that the handle could only be put on the one way —viz., to stand across when shut. If these stuffing stop-cocks were put on as described, then the ⅝-in. regulating stop-cock above referred to could be dispensed with, as the stuffing *stop*-cocks could serve both as stop-cocks and as *regulating* cocks.

*In Fig.* 319, G, H, and I, are the different parts of the

mahogany lining, while J is the wooden bar going along between the two back legs of the cabinet-stand stool, and which, being firmly fixed to the wall, prevents it from falling forward.

Fig. 320 gives enlarged perspective view of one of the brass back-check lifters, knobs, and pulleys, shown in Fig. 319. If the knob K, Fig. 320, is brass, as well as the flange L, then both may be well silver-plated, so as to correspond with the other furniture of the cabinet-stand. The end M of pull, to which the chain is attached, is swivel-jointed, so as not to twist the chain when the knob is turned round after being pulled out, to keep either a crane running or the waste-valve up, as the case may be. And to assist in keeping the back-check lifter itself from turning round, a small projection ought to be left on it when cast, as shown at N, Fig. 321. It is often a great nuisance when this projection at N is omitted.

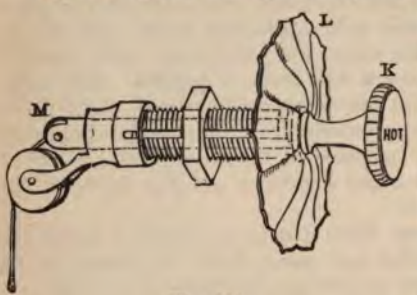


Fig. 320.

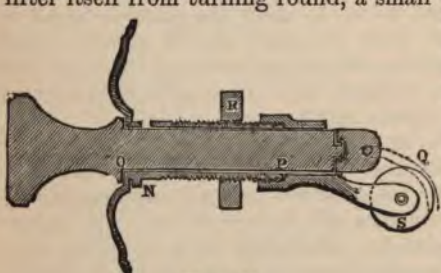


Fig. 321.

In Fig. 321 the distance from O to P is fully 1¾ in., while the distance from O to Q is 3½ in. In other cases, where there is room and it is either desired or is necessary, the distance from O to P and from O to Q may be made longer, as wished.

Fig. 322.

In Fig. 321, R is the back tightening-up or jam *nut. Fig. 322* gives cross sectional view of the *pulley* S, Fig. 321.

*As will* be seen, this pulley has a deep groove *in it all round for* the chain or cord to work in. A very

good chain is a small size of the patent copper chain, same style as used for window-weights. Fig. 323 is section of a cabinet-stand fitted up against a lath and standard partition. In this case the wash-hand basin-stool may be only a wooden shelf, no legs being needed, as the iron-brackets can be screwed up against the wooden standards, while the pipes may be placed in the space between the laths and standards.

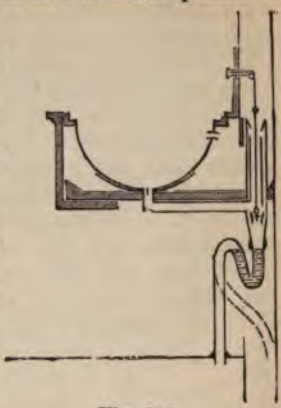


Fig. 323.

Fig. 324 is an enlarged view of the pull-up back-check lifters and knobs shown at z and A, 317 and 318. The knobs may be either of brass or china, or other material, according to taste. In Fig. 324, T T is the marble or mahogany through which the pulls work. The lead siphon-traps for the foregoing cabinet-stands may be 2 in. in diameter, and no harm will be done to put 1½ in. brass cleansing screws into them. The general size of the waste-pipe is only 2 in. in diameter, but no harm, but good, would often result to

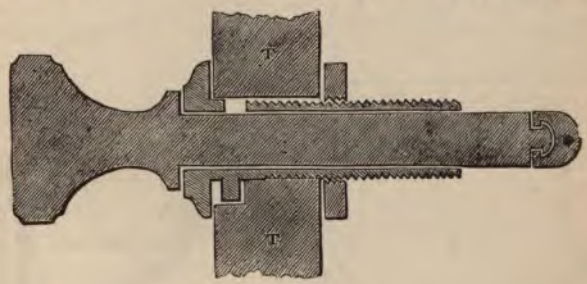



Fig. 324.

make it 2½ in., especially where it goes some distance horizontally.*

* This is more important when several basins discharge into one *main waste-pipe*. When too small a waste-pipe is used the waste-*water might* sometimes come up the safe-pipe, and cause overflow and *damage*.

In fitting on the marble top, the portion at front, as at D, Fig. 319, should not be kept any broader than is necessary for strength, as it is disagreeable for the parties using the wash-stand to have to lean forward too far. In arranging his basin on the stool, the plumber ought therefore to see that at most his stool only projects about ½ in. beyond the outer top edge of his basin or cabinet stand.

In setting his cabinet-stands and basins the plumber generally uses putty, or a mixture of putty and white-lead, and to make the putty adhere, the bottom of the basin is well rubbed with a softened piece of tallow, or a tallow candle, or the bottom of the basin may be heated and then rubbed over with the tallow. We have thought that the omission of this use of the tallow was perhaps the reason why the oil from the putty sometimes appeared through the basin, especially when the bottom of the basin outside was unglazed. In setting the marble stucco is used.

Fig. 325.

In Fig. 316, where the stool is oblong or square on top, an iron bracket is placed under each end. When, however, the front of the top of the stool is rounded off, then the two iron brackets may be connected with an iron rim, as per Fig. 325, the better to support the front of the top of the stool.

Figs. 326, 327, and 328 give plan, vertical cross section,

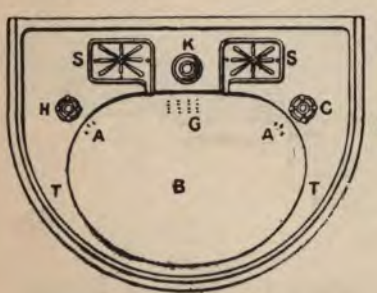



Fig. 326.

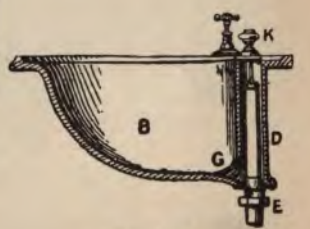



Fig. 327.

and perspective views of improved wash-basins of oval *design.** *In this* case the basin B, the table-top T T, the

* *As manufactured* by Shanks & Co., Barrhead, N.B.

grating or drainer G, the waste or discharge-pipe D, with the soap and brush-trays S draining into the basin, are all combined in one solid piece of porcelain. The clean water enters the basin through the perforations at A A. H and C are the cross handles of the hot and cold screw-down cranes. K is the knob or pull-up handle of the waste-valve—a hollow plunger—which also acts as the overflow. The handles, or exposed brass work of the cranes and valve are generally nickel-plated, so as to both look better and be more easily kept clean. E, Fig. 327, is the brass coupling for attaching to the plumber's waste pipe.

Fig. 328.

Fig. 329 shows a lavatory, oval or D-shaped wash-basin,

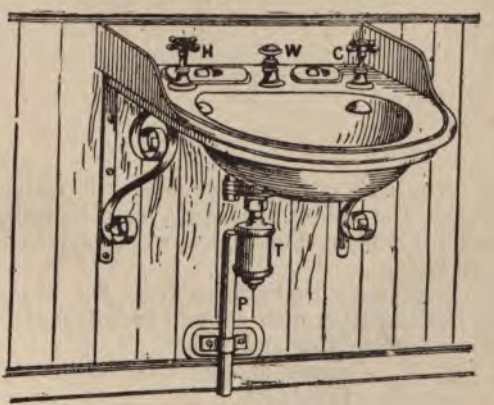



Fig. 329.

supported on wrought-iron bronzed brackets, with brass water-trap T, and waste-pipe P, all exposed, when fitted up in position as shown. H and C indicate the hot and cold cranes, and W the waste-pull. The lavatory in this case is different from Fig. 326, in having a raised back and sides.

In Fig. 330 we have another modification. The basin in this case is oblong and rounded at the corners.

In Fig. 331 we have a double wash-hand basin-stand or lavatory, with two oblong basins, each with hot and cold screw-down bib or draw-off cocks, and waste pull. In addition there is a shampooing fitting, with hot and cold water, suitable for use at either basin. This is No. 263 of Shanks'

Fig. 330.

designs. The slab on top of the basins is understood to be marble. The rest of the casing may be mahogany or other wood. Some architects, &c., will prefer to make up their own designs.

Fig. 332 shows a modification from Fig. 329. In this case the basin is fitted with a brass socket in the bottom, and an india-rubber plug and chain.

Fig. 333, again, shows another modification as regards the water supply. In this case a screw-down cold-water bib-crane being used in place of the stop-cocks in other drawings. In this illustration the basin is shown as intended to be fitted into a corner. Of course, instead of having only *one crane, it may* be had for both hot and cold cranes if *wished.*

*Fig. 334 shows* a wash-basin fitted up on Shanks' No. *300 cast-iron ornamental* stand. The stand is japanned and *fitted up with bevelled* plate-glass mirror, tile back and shelf.

This design is both artistic and sanitary. It is understood that the waste-pipe P does not join directly either a drain

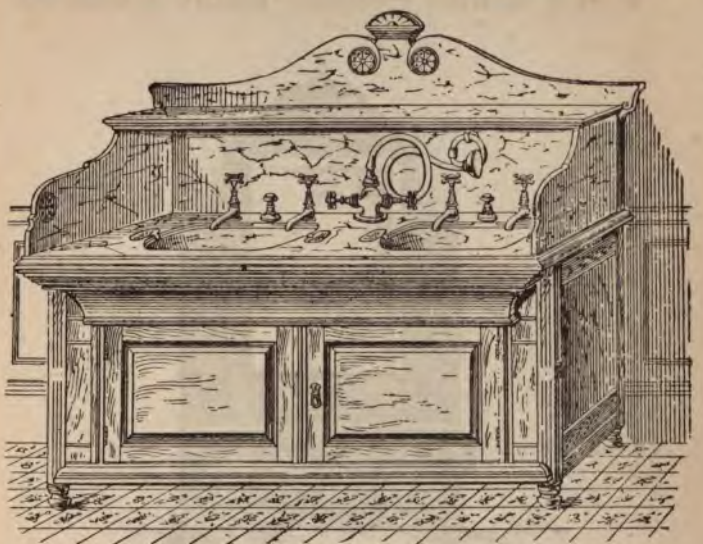


Fig. 331.

or soil-pipe, but discharges over or into a disconnecting trap, as shown at Figs. 410 and 461.

Fig. 335 shows a "tip-up" basin B, in the act of being

Fig. 332.

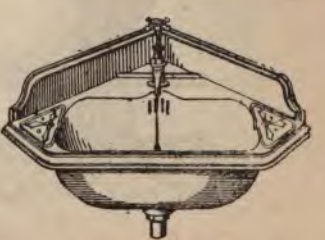


Fig. 333.

*emptied.* It is supported by and swings on two pivots, which pivots rest on the outer edge of the receiver R. Th

socket S slips into the waste-pipe or trap. Water supply for the basin may be given by hot and cold bib-cranes.

Fig. 336 illustrates a "folding" lavatory, in which the

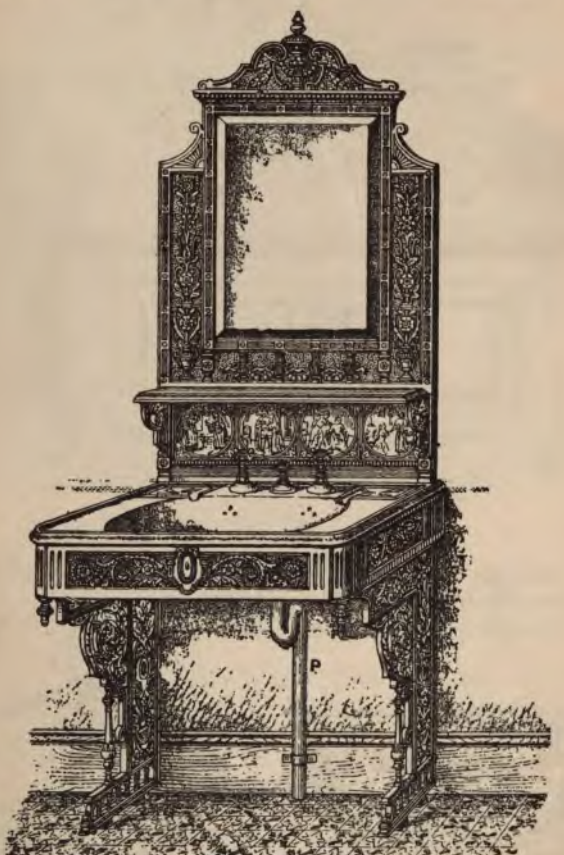



Fig. 334.

*basin is emptied* by turning it up, the waste-water discharging *into a receptacle*, which may either be portable to be *emptied by hand*, or if fixed, may have a waste-pipe from

it. As indicated by the crane, cold, or both hot and cold-water supply may be fitted for the basin.

Fig. 337 shows the lavatory shut up.

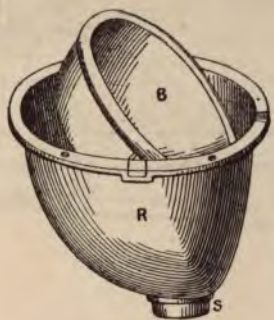



Fig. 335.

Basins are often fitted up with two near each other, and as per Fig. 338, with only one trap for the two. In this

Fig. 336.

Fig. 337.

case, *joining* the waste-pipe A into the waste-pipe B, above *the water in* the trap, is a mistake, as the discharge of the *basin on* A often sends the air in the waste-pipe up through

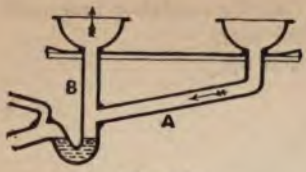



Fig. 338.

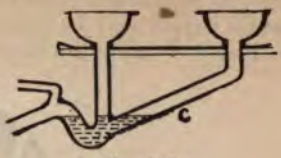



Fig. 339.

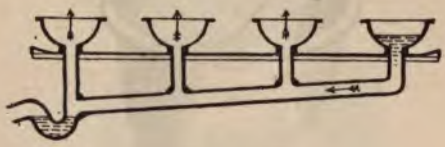


Fig. 340.

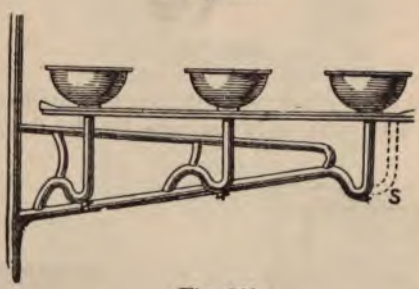



Fig. 341.

Fig. 341A.

the grating of the basin on B in an offensive manner, as indicated by the arrow.

Fig. 339 is an improvement on this, the pipe C being connected below the top of the water in the trap.

Fig. 340 shows the same defect as in Fig. 338, only worse accentuated, owing to there being more basins. The proper plan to have done the work would have been as shown in Fig. 341, by putting in a separate trap for each basin. The shorter the length of waste-pipe on the house side of each trap the better. The safe-pipe should be joined below the surface of the water in the trap, as indicated at S, Fig. 341.

Fig. 341A is illustrative of George Smith's (Glasgow) school lavatory.

## CHAPTER XXI.

### Kitchen, Scullery, and Slop Sinks.

Kitchen-Sinks are made of various materials—sometimes of wood, and often with wood lined with lead. Instead of lead, sheet copper may be used in whole or in part for the lining. In some places, again, iron is the material generally used, while in other cases slate, stoneware, enamelled fire-clay and earthenware sinks are adopted; and so on. The brasswork for the wooden sink may be the same as that shown at Fig. 243 for the wooden bath, only in this case a size smaller may sometimes serve. At Fig. 241, the bath is shown resting upon the floor; the sink in many cases will be raised up upon a stool.

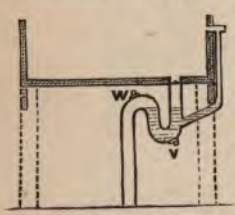


Fig. 342.

Fig. 342 is perpendicular section of wooden sink resting upon a wooden stool with four legs, one at each corner. In Fig. 342 the inside size of wooden sink is supposed to be 2 ft. long, 1 ft. 2 in. broad, and 8 in. deep, but it may be made of any size, and a lead safe may either be put under it or not, as wished, or according to its site. All the siphon-traps of kitchen-sinks should have brass trap-screws, as at V, Fig. 342. Another may also be put on, as at W, Fig. 342, or thereabout, for when grease is put down the sink it often sticks fast about there.*

* The waste-pipes of kitchen-sinks should discharge into an outside *disconnecting* water-trap, which may, if desired, have a grease-collecting division in it. My No. 2 Trap, page 270, is often used in connection with sinks, while a special grease-collecting trap may be had from Messrs. J. & M. Craig, Kilmarnock, if wished. See pages 204 to 207, where illustrations are given showing how to apply the grease-traps.

Fig. 343 gives a view of a wooden sink lined with lead, and with high back, through which the supply pipes come, and to which the cranes are attached, as shown. The sheet-lead used may be 10 lbs. or 12 lbs. per square foot for bottom, and 6 lbs. to 8 lbs. for ends and sides.* In Fig. 343 the sink has 1½-in. or 2-in. lead overflow-pipe, and 3-in. lead siphon-trap, just as in Fig. 342. The brass overflow-grating and the socket for plug are, however, different.

Fig. 343.

Fig. 344 gives view of a brass overflow grating 4¾ in. by 1¾ in., as used for either a lead-lined sink or bath. Fig. 345 is section *in situ* of a 3-in. brass socket and plug for either a wooden bath or sink lined with lead. By comparing Fig. 344 with Fig. 244, and Fig. 345 with Fig. 243, the difference in the style of the brasswork for a plain wooden bath and one lined with lead will be at once seen.

In Fig. 345 the brass plug W shown is sunk in centre; for sinks many use the plug raised in centre, with projection similar to that at X, Fig. 346; but for my own part I approve of the style shown in Fig. 345, as less apt to break the dishes. Fig. 346 is sectional view *in situ* of a brass cleansing screw for siphon-trap of kitchen-sink, as above referred to. When

Fig. 344.

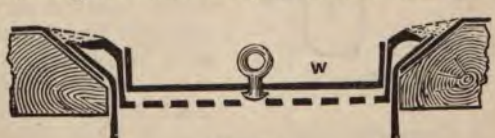



Fig. 345.

the siphon-trap gets choked up, the cover X is screwed off and the stuff taken out. 1½-in. or 2-in. cleansing screws

* See footnote page 210.

are a good size for general use; they are made larger, but I approve of the size stated, because the larger often get so stiff that they will not turn, and the size given serves the purpose.

Fig. 347 is an iron sink, or "jawbox" as it is called in the west of Scotland, with a screw-down tube-crane. In Glasgow, *e.g.*, these are in general use for the kitchens in the lower and middle-class houses. They are generally placed at the window, which is the cause why a tube-crane is shown in Fig. 347, and the reason why the handle is inclined to one side in place of being on the top is to allow the shutter to close. Supposing the distance between the bottom of the shutter and the floor to be 2 ft. 6 in., then the top of the sink will just be kept about 2 in. below the shutter; this will make the sink a very proper height and leave room for the joiner's wood.

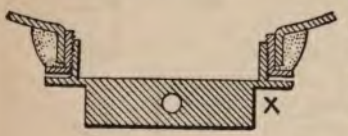


Fig. 346.

The rule for placing the sink at window is to keep the inside line of the top edge of end next shutter on a line with the daylight of the window-frame. In soldering on his screw-down tube-crane, the plumber must see that it projects sufficiently into the sink to allow the handle to turn freely after the wood lining has been put on. And to the joiner I may here say, that he may dispense with the use of *nails* for that portion of the upright wooden lining immediately before the siphon-trap, as it often requires to come off; therefore $1\frac{3}{4}$-in. brads or "sprigs" will do.

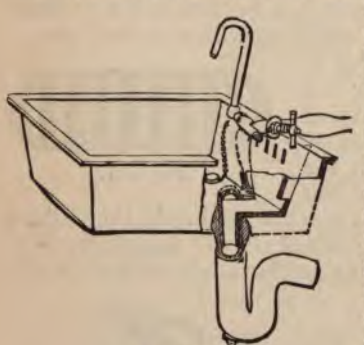


Fig. 347.

*In place of* brads, some use screws here. Many local *brass-founders make* screw-down tube-cocks, but those made *by Guest and Chrimes* are in large demand; consequently, *while I formerly* approved of their work in connection with

other things, they must excuse me pointing out a fault in connection with these, and it is simply this: that, although I have seen scores of them put on for some time back, in, I think, most cases the nut at the end of the barrel was too slack—turning round quite easily with the fingers—and, as a consequence, a few days after the crane would be put on, the tube would not stand up properly, while the water leaked at the key. A partial remedy for this was to squeeze the nut of every crane in the vice. The proper remedy, however, is for the *makers* either to reduce the size of the hole in their nuts, or else to leave the male screws larger—not merely thicker at the point as has been so often and so stupidly the case, but of the same thickness all the way up, so that the nuts referred to may fit tightly. Considerable improvement might also be made in regard to the stuffing-box, or in the material used for stuffing.

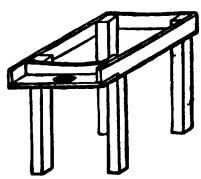


Fig. 348.

Only two days ago one of the water company's officials made a complaint to me on this latter point. I made an objection to Lambert's cranes that the bush and screw so often gave way; he retaliated by condemning Guest and Chrimes's cranes because the stuffing-box did not keep tight sufficiently long. Now, which of these well-known firms or their imitators will be the first to remove the objections above made?*

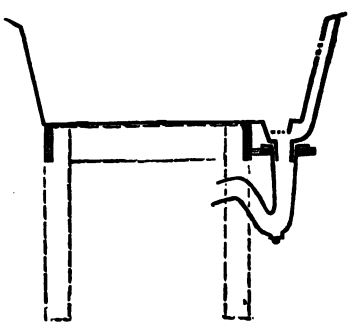


Fig. 349.

The sizes commonly employed of the iron sinks, or "jaw boxes," shown in Fig. 347, are, for small houses, 21 in. long, 13½ broad, and 8 in. deep, or 24 in. long by 14 in. broad, and 8 in. deep. For larger houses, iron sinks 27 in., 30 in., and 36 in. long, are

* *Sir William* Thomson—now Lord Kelvin—brought out an improved screw-down crane. It is manufactured by the Palatine *Engineering* Company, Limited, Liverpool.

used; they can be had, however, either smaller or larger than these sizes, up to 6 ft. in length.

Fig. 348 shows how the wooden stool which supports both the iron sink and its lead siphon-trap is made. As the bottom of these iron sinks is slightly rounded, the two cross-bars of the stool must be made slightly concave on the top to suit. Fig. 349 is longitudinal section, showing how the iron sink, wooden stool, and siphon-trap come together, and how the siphon-trap is supported by its top being simply beaten out and turned over upon the wood as shown, the slip of the horn of the iron sink into the top of the lead siphon-trap being made good with putty. In setting these sinks, they should be kept a little lower at the end next the outlet, so that all the water run into the sink may flow freely away.

Fig. 349A.

In Fig. 347 only one crane is shown; but if there be hot water in the house, another tube-crane may be put on alongside the one shown. The one farthest off may have its handle right on the top; and if that interferes with the closing of the shutter, the bottom of the shutter may be cut to suit. If, however, the plumber is aware, when fitting up his sink, that hot water is to be put in, by keeping the sink a little lower the shutter will not require to be cut.

Fig. 349A is sketch of a four-pronged handle as often used on screw-down bib-cocks.

Instead of the kitchen-sink discharging into a disconnecting siphon-trap, as into one of my No. 2 traps, it may discharge into a Buchan's grease-trap, manufactured in fire-clay by Messrs. J. & M. Craig, of Kilmarnock, or in iron by Messrs. Walter Macfarlane & Co., Saracen Foundry, Glasgow.

Figs. 350 and 351 show different styles of fitting these grease traps in position. In Fig. 350 the grease trap is put in with its top on a level with the ground, as in private situations where persons do not walk over it. A is the inlet end of the trap, C the outlet end, B is the oval grease compartment where the grease lodges, and where it can be *lifted out as necessary*. In some cases once a fortnight, in *others once a month*, or once in three months. E is a portable *lid over the* grease chamber. Above C is a movable *lid, sealed down with* lime and Roman cement. It can be

lifted when wished to get at the outer end of the trap. This is seldom necessary, however; D affords ready access at

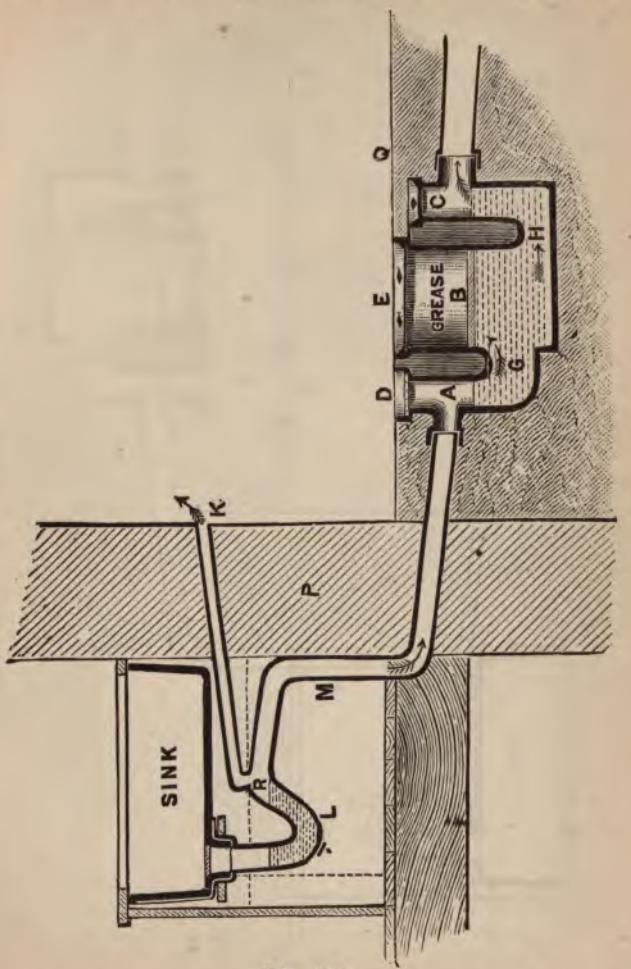



Fig. 350.

*all times to the* house end of the trap, and at D a small *fresh-air inlet* grating may be placed. The fresh air enter

ing at D goes up the waste pipe M and out at the air pipe K. Q, Figs. 350 and 351, indicates the level of the ground.

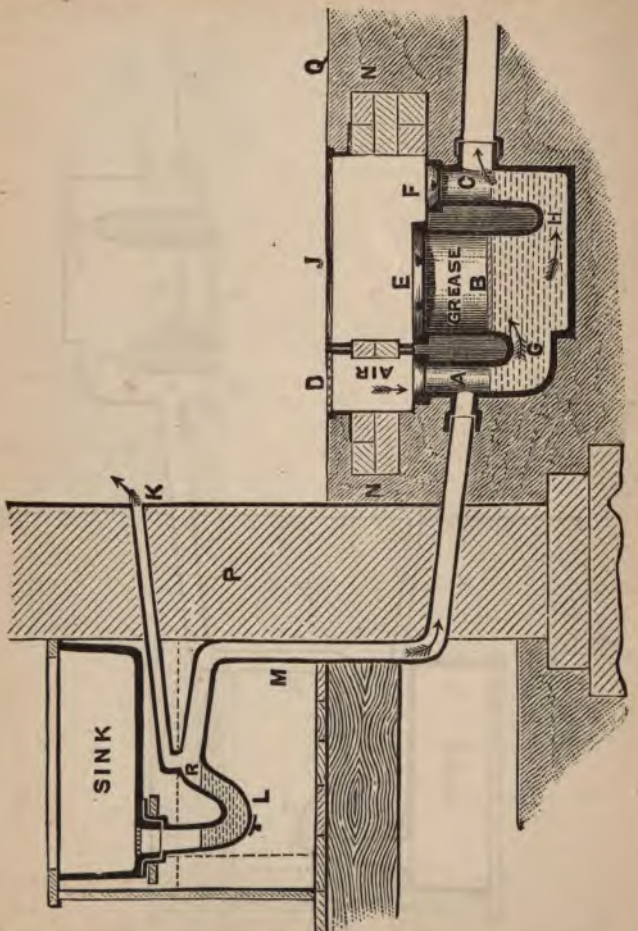



Fig. 351.

*In Fig. 351 the grease trap is set some distance below the ground, and has a strong cast-iron plate* J, 21 in. × 11 in., *set in strong* iron frame over the grease chamber, B;

D is an 8-in. iron grating in iron frame. The small fire-clay or iron access lid F is kept sealed down with lime and Roman cement on top. The lid E is loose. M is the waste pipe from the sink, K its air pipe, and L the lead siphon-trap with a brass trap-screw in its bottom. P is supposed to be the back wall of the house. This trap is made in two sizes, and is the best style of grease trap in the market. It has been in use for years at Balmoral Castle, the Highland

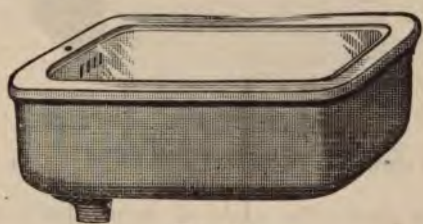


Fig. 352.

residence of her Majesty the Queen, and at many mansions, hotels, and private houses throughout the kingdom. Further information may be had from the makers.

Enamelled fire-clay sinks are now largely used. The white ones are the best. They are strong, about 2 in. thick, and clean-looking, and can be had in various styles.

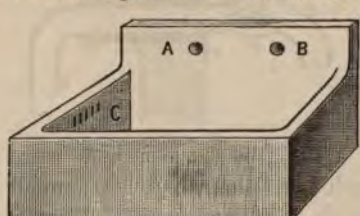



Fig. 353.

If it is not intended to line them in with wood, the front part, or where exposed, may be enamelled as well as the inside. It makes a clean job to set them upon white enamelled bricks where they are exposed. Figs. 352, 353, and 354 show three different styles of these sinks, as made by Messrs. J. & M. Craig; the two latter with high backs, through which the hot and cold water cranes are ofte

fixed, as indicated by the holes at A and B. It will be observed that while Fig. 353 is only raised along the back, Fig. 354 is raised both along back and on one end, as if to

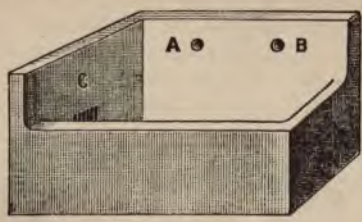



Fig. 354.

be set in a corner. They may also be had with both ends raised.

Fig. 355 shows the mode of fixing the water cranes through the holes A and B, Fig. 354. The nose crane B, with long screwed tail and flange F, has said screwed tail

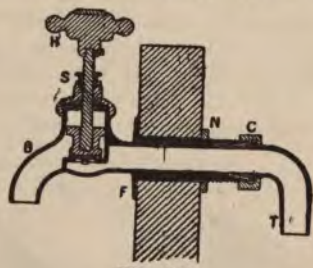



Fig. 355.

pushed through the hole, when the jam-nut N is screwed up tightly with a lead or leather washer; the coupling tail T being then attached by the coupling ring C.

Figs. 356 and 357 show two modes of attaching the lead waste-pipe to the brass waste-socket. In each case the brass socket is soldered to the top of the lead pipe. In *Fig. 356* the overflow of the sink is by the lead mouth-*piece, M (with brass grating at G), and the 1½-in. lead over-flow-pipe O. In Fig. 357 the overflow is in the thickness or body of the end of the sink.*

*The lead pipe, where it passes through the bottom of the*

sink, is made tight with hemp and redlead. Instead of the lead pipe, a brass socket with a long screwed tail and a

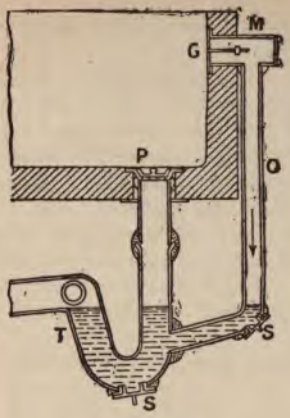



Fig. 356.

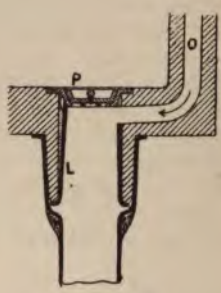



Fig. 357.

jam-nut might be used for the bottom, and especially for Fig. 356.

Fig. 358 shows such a socket with a jam-nut J, on it.

Fig. 359 shows brass socket with not only the jam-nut, but also with a brass coupling C.

Both for wash-basins and sinks great annoyance often

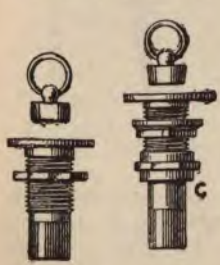



Fig. 358. Fig. 359.

Fig. 360.

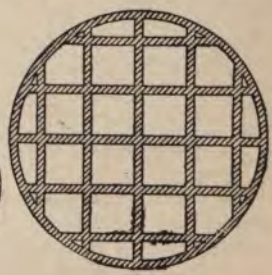


Fig. 361.

arises from the holes in the grating being much too small. *Round holes only* ¼ in. or less in diameter easily get choked *up, hence, for* wash-basins, it is better to form the bottom

of the grating as per Fig. 360, with only a metal cross in bottom so as to leave four holes, each nearly ½ in. wide; then for the waste-grating of the sinks, which may be about 2½ in. or 3 in. in diameter, form the holes in the spider-web pattern, shown in Fig. 361.

Slop-sinks may be formed of either enamelled fireclay, enamelled iron, or tinned sheet copper.* They are better to be made with the back and two sides from 4 in. to 9 in. higher than the front, and the corners, especially near the bottom, rounded. Where cheapness is the desideratum, a wash-down closet may answer the purpose very well when fitted with a lead tray round its top. In many cases closets have been fitted up to serve as closet, urinal, and slop-basin, the seat being hinged to lift. In large establishments and hotels, &c., slop-sinks independent of the closets are advisable.

Fig. 362 is sketch of Mr. S. S. Hellyer's "Water-shoot"

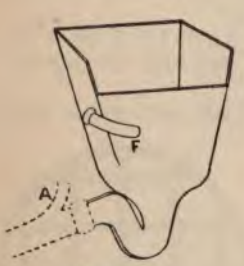



Fig. 362.

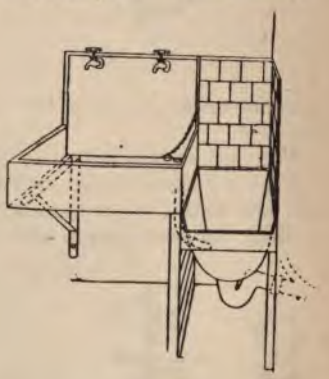


Fig. 363.

slop-sink. It may be supplied from a regulating or waste-not cistern overhead. Another style of fitting it up is in conjunction with a wash-up sink, as per Fig. 363, in which case the slop-sink is flushed by filling the wash-up sink with

* *Sheet copper* is often used for the bottom of kitchen-sinks, where *the sides and ends* are of lead, especially where there is hot water *supply. The copper* used may be from 4 to 5 lbs. per square foot. If *the sides and ends* are also of copper, then about 2½ lbs. per square foot *may do for these.*

water, the discharge from which flows into the slop-sink. As this wash-up sink and the slop-sink are intended for the bedroom utensils used for slops, it is safer to draw clean water for the bedroom carafes from the pantry sink. Conscientious and sensible cleanliness is a great desideratum in the servants in this relation. Frequent washing of the hands with soap and water is to be encouraged for the safety not only of others but of themselves.

This chapter was re-written after the fourth Annual Congress of the Delegates of the Scottish Plumbers' Registration Movement was held in Aberdeen, at the beginning of September, 1893. On the afternoon of the second day a visit was made to Sir William Cunliffe Brooks's house, at Glen Tana, near Aboyne. Sir William showed the delegates the various sanitary arrangements about his premises, including his system for the disposal of the sewage on the fields.

Afterwards, in a letter to the author, he remarked that his mind had been much exercised as to the best material to use for water-pipes. He objected to the too general use of lead on account of the danger,* and did not approve of galvanized iron pipes for water supply. I suggested the use of copper pipes, tinned both inside and out—the edges of the pipes being also tinned as well as the inside of the brass couplings.

Tinned copper pipes (solid drawn ones are the best) are largely used for hot-water supply pipes in houses, why not also use them for the cold supply? They are much more expensive than lead; but what does that signify to those who can afford the extra price? Gold-cased watches are preferred by many to silver merely for appearance sake, although the works in both cases may be alike. It would be often more beneficial to the health, however, if people used tinned copper for their water-supply pipes in place of lead.

Even with those pipes and the water supply off the main direct, it is better to run off the water lying all night in the pipe between the crane and the main before drinking.

* He mentioned an instance of a gentleman killed by lead poisoning. He had a *pump* with a wooden tail pipe, but the tail being short *some one added* a piece of lead pipe to it—probably using white lead at *the junction*—and the gentleman was killed by lead pollution while he *thought no lead* was near the water.

Tinned sheet-copper might also be used for cisterns. Those who could afford it might use sheet block tin. "Tin-plated sheet lead" has been used for cisterns, and "lead-encased block-tin pipes" for water pipes. This pipe is not merely washed or coated with tin, but is a compound pipe—a tin pipe enclosed within a lead one. Pure block-tin pipes, same as for gas, are used for spirits, *i.e.* whisky, &c.

In the foregoing remarks I have supposed that every particular house has a private or internal water-supply for itself. In many cases, however, a number of small houses will only have one water-supply between them, say, a well set up in a back court. In order to prevent undue waste of the water, it has been found necessary to so construct this well as that it shall only run so long as the hand is held to it. If a common screw-down bib-crane be employed, it is nothing unusual for it to be left running for hours at a stretch; consequently, such a well as Kennedy's self-closing well has been largely used. One style is that with the round iron case, about 9 in. in diameter and about 3 in. deep, with a round handle projecting through its face, as per Fig. 364; a weighted lever attached to the spindle inside causes the crane to shut whenever the hand is removed. More ornamental styles may be had.

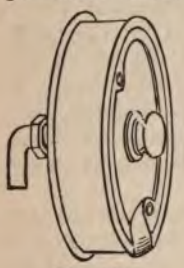


Fig. 364.

## CHAPTER XXII.

### WASHING-HOUSES.

WHEN Achilles was dipped by his mother in the river Styx to make him immortal, she omitted to submerge the heel she held him by, which omission, as the legend goes, cost him his life, he being shot in the heel by an arrow. In like manner, in many houses which are supposed to have been put into a good sanitary condition, some vulnerable part has not been properly protected; and this part is often the wash-house. It may be that an old-fashioned iron bell-trap has been left in the floor to carry off the surface water, which bell-trap may often be unsealed either by evaporation or by having its loose cover removed. The effect of this will be all the worse if the wash-house drain is not disconnected by an intercepting trap from direct aerial communication with the main drain. Or it may be that something is wrong in connection with the waste-pipe of the tubs. See that nothing is wrong.

Fig. 365.

In the *good* old days the wash-house had often the appearance of a dilapidated charnel-house; now-a-days it is a pleasure to one with sanitary tastes to visit a well fitted-up and tidily-kept wash-house. It may have a granolithic floor, with anti-bell-trap, as per Fig. 365, to carry off the surface-water, white enamelled tiles 4 ft. or so up the *walls, enamelled* fire-clay wash-tubs, set either upon white *enamelled bricks* or upon special enamelled stands, as per *Fig. 366, each* tub having both a hot and cold-water tap.

Then the boiler may be copper, with hinged lid and steam-pipe, while the wash-house itself is also ventilated at its roof. Wooden foot-boards are also provided for the persons

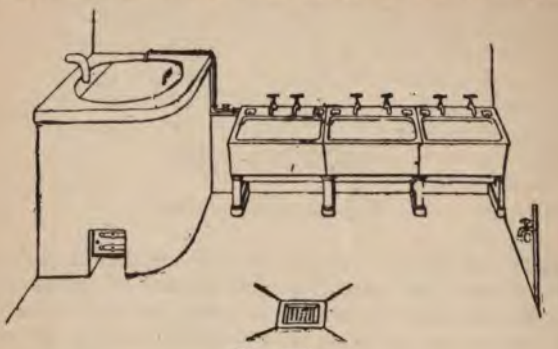


Fig. 366.

standing upon when washing at the tubs, in order to keep their feet dry and warm.

Perhaps the first substantial improvement upon the old round, wooden, portable tub was the square or oblong wooden tubs, made of 1½-in. or 2-in. thick wood, set up upon a strong wood frame, and fitted with brass plug and socket in bottom for emptying, as per Fig. 367. At first these might be filled either by hand with a bucket, or, as I have seen, with a portable gutter; but loss of time and inconvenience soon caused the water-supply to be attached to each tub. Either one cold-water crane only to each tub or in other cases both hot and cold cranes.

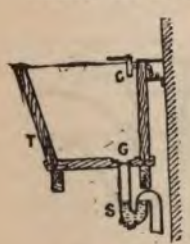



Fig. 367.

In many cases this hot crane had its water supply from the wash-house boiler, and therefore could only supply warm water when said boiler had a fire below it and warm water in it. This proving an objection in many cases, those houses which had a good and suitable hot-water supply had the hot-water supply for the wash-tubs also taken off the kitchen boiler pipes, so that hot water could be got at the wash-house tubs at a moment's notice. Evolution has, therefore, also played its

part for the better in wash-houses as well as in other earthly spheres.

Fig. 368 is vertical cross sectional drawing of a wash-house with draw-off water-crane C for filling pails or portable tubs; W indicates the position of the fixed tubs; S is the 4-in. siphon trap, with surface grating for carrying off the water spilt on floor; T is a 4-in. No. 2 Buchan disconnecting trap locking off the wash-house drain and waste-pipes from the main drain; V is a 20-in. or larger Buchan's induced-current exhaust ventilator, with 12-in. diameter or larger pipe P leading up to it, for ventilating and carrying off the steam and vapour from the wash-house.

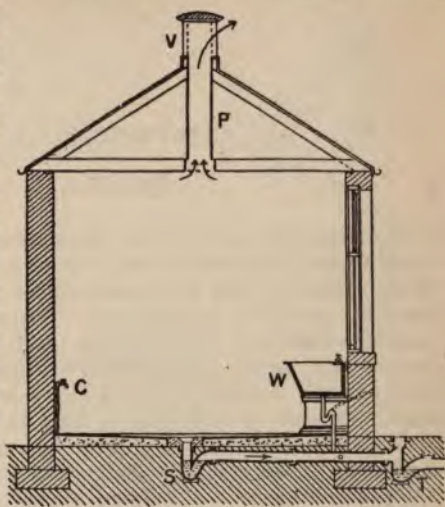



Fig. 368.

Fig. 368A shows the waste water from the tubs discharging above ground through the waste-pipe W above the grating of the 4-in. fireclay siphon-trap S. The siphon-trap S in this case serves to carry off the water from the tubs, and also what is spilt or thrown upon the floor. The waste water passing through the trap S discharges into the 4-in. Buchan No. 2 trap T, *which trap T locks* off the wash-house from the main drain.

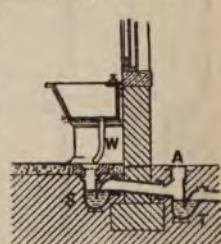



Fig. 368A.

## CHAPTER XXIII.

### URINALS.

URINALS are of various styles—high-backed and low-backed, round-backed, flat-backed, and cornered. They may have either short or long projecting lip in front. These are generally made of earthenware. Then there are public urinals, sometimes made of iron and painted, or partly painted and partly enamelled. Or earthenware may be used for the urinals proper, with enamelled tiles for the walls. Or slate or marble slabs may be used. Urinals are not so much used now in private houses and offices as formerly, on account of the disagreeable smell often arising from them, and because their use has in many cases been rendered unnecessary where water-closets with hinged seats, as shown in Figs. 210 and 234, are fitted in.

Fig. 369.

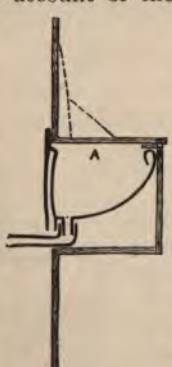


Fig. 370.

Fig. 369 is vertical section of a high-backed cradle urinal with a ½-in. screw-down stop-cock at Y, and a 2-in. lead siphon-trap with brass tap-screw at Z. In addition to the foregoing exposed crane, another crane is often put on underneath the woodwork, somewhere where the plumber can get access to it; this latter *crane is intended* to serve as a regulating crane to prevent *too much water running* into the urinal at once and over-*flowing it. Fig.* 370 is a section of a small flat-backed *urinal in situ.* When the wooden lid A is lifted it pulls a

cord which opens a crane and causes the water to run all

Fig. 371.

Fig. 372.

the time lid is up. The lid may be held up with a spring-

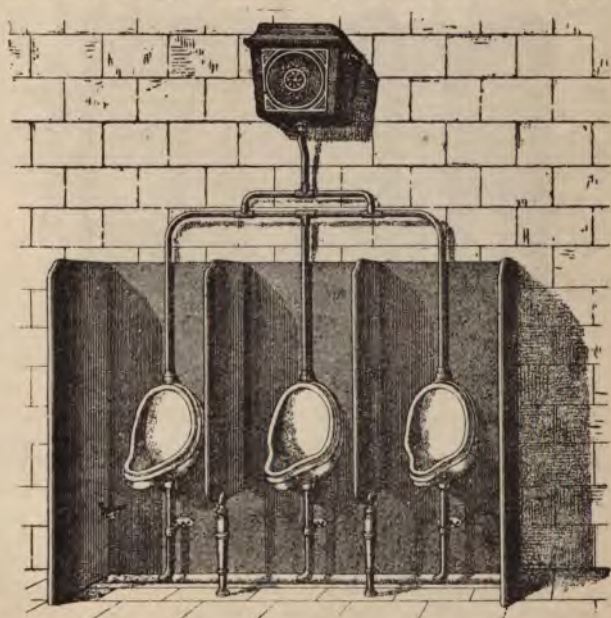


Fig. 373.

*catch during* use. Another style is to place a crane unde

the floor immediately before the urinal, which causes the water to run so long as any party is in the position to use the urinal. Or a siphon regulating cistern may be used.

The shorter the distance between the top of the water on the house side of the siphon-trap and the urinal basin the better. It is best therefore when the water trap is right below the outlet of the basin. The grating in the bottom of the urinal is often made loose so that it can be easily lifted out and the pipe below it brushed and cleansed.

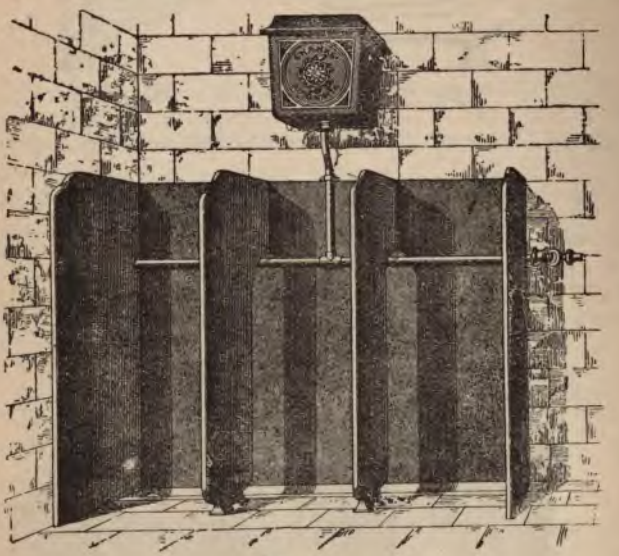


Fig. 374.

Fig. 371 is a sketch of a flat-backed earthenware urinal with projecting lip. This style is largely used in hotels and at railway stations, &c.

Fig. 372 shows vertical section from back to front of an Armstrong's urinal in the act of being flushed. Siphonic action sets in when the water goes down the waste-pipe P, so that the water in the basin is sucked out at each flush except a little left in the bottom sufficient to form a water-lock.

*Fig. 373 is a urinal* range with three urinals or divisions

Fig. 375.

Fig. 376.

fitted up with an earthenware urinal with projecting lip in each division. The water supply is shown as coming from a cistern overhead, which may be fitted with apparatus to flush the urinals at intervals automatically. The waste-pipe from each urinal, in this case, is only about 2 ft. long, and discharges the water upon a grooved channel or gutter formed in enamelled fire-clay. The back of the range and the divisions may be *made of either* slate or polished marble. The down supply-

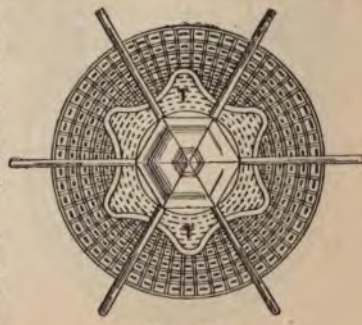


Fig. 377.

pipes from the cistern to the urinals are supposed to be of copper.

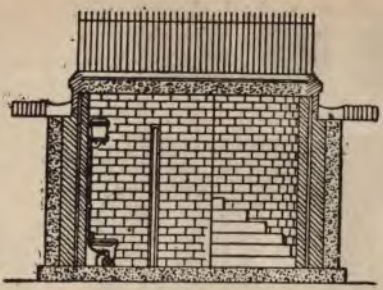


Fig. 378.—Vertical Section on line A B.

Fig. 374 shows a range with the earthenware urinal basins omitted. The flushing is from the cistern overhead, the horizontal copper-pipe having a number of small holes perforated or bored in it for water jets. The slate or marble divisions stand out below the copper tube about 3 ins. from the back. The waste water flows along the gutter into a 4-in. siphon-trap.

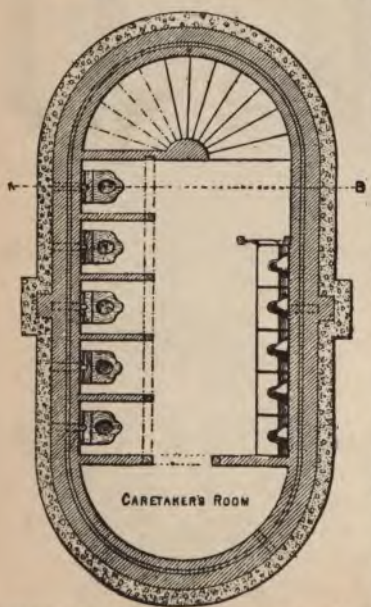



*Fig. 379.—Plan below Pavement.*

Fig. 375 shows a Shanks urinal range with the backs made of angular blocks of white enamelled fire-clay, and the divisions and upper fittings made of cast-iron. Each division has a cistern for itself. The illustration is taken at the moment of flushing.

Fig. 376 gives a vertical section in which the waste water is shown as intended

to flow off into the 4-in. fire-clay siphon-trap set underground.

Instead of being fitted up against a wall, the urinals may be erected in the centre of a space as per ground plan Fig. 377, here shown of a urinal with six divisions in it, T T is a basin or water-trough set up about 2 ft. 3 in. above the ground, and kept full of water to a certain level, clean water coming and pushing away the foul continually.

The advance of civilisation still calling for further improvements, we have of late years not only public urinals but also in combination with them water-closets fitted up, and placed underground* so as not to form eyesores where they are placed. Figs. 378 and 379 give vertical section and plan of one of these. Selfishness or modesty—whether false or not—has tended hitherto to prevent the same consideration being given to the wants of the gentler sex as has been awarded to the stronger half of humanity, but the claims of nature for justice all round are now commanding attention. Walter Macfarlane & Co., Glasgow, and Shanks & Co., Barrhead, have been among the pioneers in this connection.

* Sometimes in the street with stair down as shown on right-hand side of Fig. 378 and at end of Fig. 379.

## CHAPTER XXIV.

### Glasgow Loch Katrine Water-Supply.

As showing how the water-supply to the various houses in a city is taken off from the water companies' iron main pipes, I may now point to Fig. 380, which shows the style and mode of attachment of the ¾-in. underground stop-cock and screwed ferrule, both brass, as allowed to be used by the Glasgow Water Commissioners for connection to their water-pipes.

The distance between the stop-cock and the ferrule is about 2 ft. The stop-cock must not be riveted, but have tightly-fitting nut and washer.

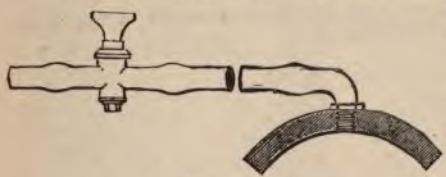


Fig. 380.

In order to get access to the stop-cock when necessary, it must be surmounted by a proper stop-cock case, with lid, which case is set upon bricks. The depth of the stop-cock under the surface of the street may be from 1 ft. 9 in. to 2 ft. When deeper it is often unnecessarily difficult to get at. For handiness, an extra stop-cock is often put in on the pavement, or some other suitable place. As the body of the stop-cock in street is generally concealed from view, it ought to be a rule that all underground stop-cocks, such as in Fig. 380, should be put in straight across the street. This enables the plumber to properly turn off and on the water with ease, and so save time.

*At* Glasgow, which is celebrated for its first-class water *supply, from the bosom* of the far-famed Loch Katrine, the

height of the water in reservoir at Mugdock above the mean level of the water in the harbour is about 317 ft. The whole of this great pressure, however, is not allowed to be wasted by being let on to the lower parts of the city, for by a system of check-valves the pressure about Argyle Street, *e.g.*, stands at about 45 lbs., or about 100 ft. throughout the day, and at night it may rise up to about double that. The full pressure is, therefore, kept for the higher portions of the city, where it is required. The weight of the lead service-pipes off the pressure, as regulated by the Glasgow Water Commissioners, is as follows (as per A.D. 1893 Bye-Laws) :—

| | | | | |
|---|---|---|---|---|
| ½ in. diam. | internally, | 7 lb. | per lineal | yard. |
| ¾ in. do. | do. | 11 lb. | do. | do. |
| 1 in. do. | do. | 16 lb. | do. | do. |
| 1¼ in. do. | do. | 22½ lb. | do. | do. |
| 1½ in. do. | do. | 30 lb. | do. | do. |

I think these weights, as specified for the different sizes, very good, and when put in so a first-class job is made. For London I see the weights for the same sizes are rather less—viz., ½-in., 6 lbs. ; ¾-in., 9 lb. ; 1-in., 12 lb. ; and 1¼-in. 16 lb. per yard. I expect, however, that the London pressure will not therefore be so strong as that of Glasgow. If not so strong, then pipes when put in of these weights will make a very good job, *i.e.* when the pipe is properly made —viz., of the same thickness all round. The practice now of putting on screw-down cranes saves the pipes greatly by preventing concussion when being shut. Although, as stated above, ¾-in. ground stop-cocks are allowed off the Water Company's main pipe in street, for sizes at or above 2 in., slide-valve sluices must be used.

As partly related on the granite tablet built into the pediment erected over the entrance to the Loch Katrine aqueduct, the Loch Katrine Water Works were designed in 1853 and 1854, Robert Stewart being then Lord Provost. The Act of Parliament was got with the aid of Lord Palmerston in 1855, and the works commenced in the spring of 1856, Mr. Andrew Orr being then Lord Provost. An opening ceremony took place near the top of Loch Chon on the 20th May, 1856, and on the 14th October, 1859, the water was first admitted into the aqueduct, her Majesty Queen Victoria personally turning the sluice. The water was introduced into Glasgow on 28th December, and by

March, 1860, the supply was general throughout the city. In token of their appreciation of the genius and skill of their engineer, the Town Council and a number of the most influential citizens entertained Mr. J. F. Bateman to a banquet on the 23rd October, 1860.

The cost of the works than amounted to upwards of £900,000, the distance traversed being fully thirty-four miles.* The work was completed in less than four years. As Mr. James M. Gale, the present engineer to the Glasgow Water Commissioners, observed, it is a work which will bear comparison with the most extensive aqueducts in the world, not excluding those of ancient Rome; and it is one of which any city may well be proud.

An interesting paper on the Loch Katrine works was read by Mr. Gale, before the Institution of Mechanical Engineers, in A.D. 1864, from which some interesting information may be culled.

The drainage area to Loch Katrine Water Works amounts to 45,800 acres or about 72 square miles, and includes Lochs Katrine, Achray, Vennacher and Drunkie. Storage capacity is 910,000,000 cubic feet.

The drainage area to Loch Katrine alone is 22,800 acres, and area of Loch itself in summer 3,000 acres. The district is rugged and mountainous, and rainfall very heavy; in some years about 100 inches in certain parts down to 60 inches elsewhere in the lower and more open country.

The works of the Loch have been arranged to secure a supply to Glasgow of 50,000,000 gallons of pure water per day, independent of providing compensation to the river Teith. The supply for the city is from Loch Katrine. The compensation water comes from Lochs Vennacher and Drunkie. This compensation was fixed to be 40,500,000 gallons of water per day.

The length of the aqueduct from Loch Katrine to the Mugdock service reservoir is 25¾ miles, and from the reservoir to Glasgow about 8 miles more. The built and tunnelled part of the aqueduct is 22 miles long; it is 8 ft. high by 8 ft. broad with a fall of 10 in. per mile, or 1

* In addition to the then cost of the works, *per se*, there had to be *taken into account* £674,000, being sums annually payable to proprietors *in the two* previous water companies, capitalised at 4 per cent. *In the present decade* (1894-95), owing to the increase of the population, *the works* are being extended.

in 6336. The valleys of the Duchray, the Endrick, and the Blane make a length of 3¾ miles, which have cast-iron siphon-pipes 48 in. diameter, with a mean fall of 1 in 1,000. These pipes deliver fully 20,000,000 gallons per day. Provision was left at the bridges, &c., for laying two additional pipes when such was demanded by the Glasgow consumption.

The first work on the line of the aqueduct from Loch Katrine was a tunnel fully 1¼ mile long. The rock was a hard mica slate. In some parts the work, although carried on night and day, only proceeded at about 3 lineal yards in a month. The portion of the contract for 7½ miles from the loch cost £23,000 per mile, £10,540 being spent on gunpowder.

The minor ravines are crossed by aqueducts of iron.

At some of the shorter bridges the aqueduct is covered over with light cast-iron beams and concrete arches, while some of the longer ones are covered over with planking at the ends to prevent the aqueduct being choked by drifting snow. Grooves are left in the masonry to receive stop-planks, and discharge sluices put in for repairs. Overflows exist at a number of the bridges to discharge the water, if it should be necessary to stop the flow suddenly at any point. Where the ground was cut open the surface was restored after the aqueduct was built.

To the iron flanged pipes where exposed injury resulted from expansion and contraction, but a covering of felt, about ¾ in. thick, protected from the weather by tarpaulin covers laced tightly, obviated this.

The water from Loch Katrine is drawn off at about 2½ miles from its top on the side nearest Glasgow. It is first admitted into a basin 55 ft. long by 40 ft. wide, through three cast-iron sluices, each 4 ft. square. Across the width of the basin is stretched a line of strainers, to keep fish, &c., from passing from the loch into the aqueduct.

Mugdock Service Reservoir has a water surface of 60 acres, and is 50 ft. deep. The top level of the water in it is 312 ft. above sea-level. The reservoir contains 548,000,000 gallons when full. This in 1863 was equal to a supply for 29 *days. In* 1875, to a supply for 17 days; and in June, *1893, to a supply* for 12 days. On June 19th, 1893, after *several weeks'* drought, there was still impounded in Loch

Katrine 74 days' supply, independent of contents of the service reservoir. On June 22nd heavy rain began to fall and continued for some days, relieving the minds of those who began to fear shortness of supply.

While in November, 1863, the average quantity of water sent into Glasgow from Loch Katrine was about 17,000,000 gallons a day, the quantity consumed for domestic and other uses, independent of that supplied by meter, being then 39 gallons a head, the quantity sent in in 1892 was 43,000,000 per day, or 33 gallons per head for domestic use. Then, while the average daily quantity sent in during July, August, and September, 1875, was 31,300,000, or 52 gallons a head *over all*, but deducting 7 gallons for meter supply and 7 gallons for other trade purposes, there was left 38 gallons a head per day for domestic use, the amount sent in in July, August, and September, 1892, was 44,000,000, or 50 gallons per head, but deducting 17 gallons for meter and trade purposes, we have left 33 gallons per head per day for domestic use. During the drought in the middle of June, 1893, the daily average consumption of one week was fully 47,000,000 gallons per day. On one of the days it rose to 50,750,000 gallons for the whole city.

For some years after Glasgow got the Loch Katrine supply, a considerable amount of the water coming into the city ran to waste owing to defective fittings. While this waste might be good for the sewers in the lower part of the city, its tendency was to reduce the pressure in some of the higher parts, hence the necessity for insisting on improved fittings, waste-preventing valves for water-closets and urinals, and a body of inspectors to regularly examine the condition of the water-fittings in houses and other buildings, so as to check this waste. Further, although Glasgow in 1870 might have afforded to use its water-supply lavishly, the great increase of the population since then has necessitated the curtailment of all waste.

In 1863 the annual revenue was £90,000, with a domestic rate of 1s. 4d. per pound of rental. In 1887 revenue amounted to £161,000, with the rate reduced to 7d. per pound of house rental, with a public rate of 1d. per pound *upon all property* within the city. In 1892 the revenue *was £170,000,* the domestic rate within the municipal *boundary being* 6d. per pound, and beyond the municipal *boundary 10d.* per pound.

In the foregoing remarks no mention is made of the Gorbals Water-Works, which were executed for the supply of the population on the south side of the river. These works are comparatively small, yielding only about 5,000,000 gallons per day. This is included in the above 1892 consumption.

To return to the Loch Katrine works, the water in entering the reservoir flows over four cast-iron gauge plates, each 10 ft. long, brought to a thin edge, so that the water passing may be gauged regularly.

There is a straining-well in which the water passes through copper wire-cloth of 40 meshes to the inch. This catches floating straws and other matter. Provision is made to clean the strainers. Filtration is not needed.

Two lines of cast-iron pipes, 42 in. diameter, are laid in the tunnel leading off from the straining-well. These would deliver 50,000,000 of gallons per day, but on emerging from the tunnel, which is 440 yards long, they are diminished to 36 in. diameter, provision being made for additional pipes when needed. At the point where the pipes are reduced to 36 in. diameter, a self-acting throttle-valve is fixed on each pipe to shut off water in case of burst or other accident, causing the velocity of the water to be increased beyond what the valve is adjusted for. These valves were suggested by Sir William G. Armstrong, and were first used in the Manchester Water Works.

At intervals, along the line of the mains to Glasgow, and at several points in the city, stop-valves are fixed in the large pipes. To allow the valve to be easily closed or opened, the slide is divided into two compartments, one much smaller than the other. The smaller one is first opened, and the passage of the water through it reduces the pressure on the larger valve so much, as to allow it to be easily opened, and by one man.*

In the case of the valves on the 36-in. pipes, instead of the water passage in the 36-in. valve being about 7 sq. ft., (or equal to the full bore or area of the pipe), it is only 4½ sq. ft. The smaller slide having an area of 1 sq. ft., and the larger slide an area of 3½ sq. ft.

The concussion caused in large pipes by suddenly closing

* *It requires great* power to open or shut a very large stop-valve *under considerable* pressure. A column of water of 100 lbs. on the *square in. has a* pressure of 45 tons on a slide-valve 36 ins. diameter.

the stop-valves has to be guarded against. This is partly done by the construction of the valve itself; but momentum valves are also fixed on the pipes near the large stop-valves, and behind the self-acting throttle-valves. Air-

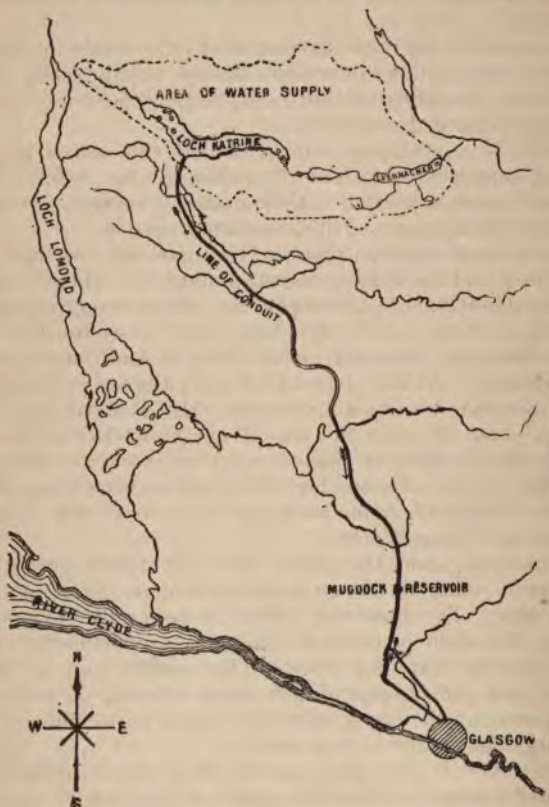



Fig. 381.

valves are placed at the summits, and scour-cocks at the bottom of hollows on the mains.

*The scouring* and stop-valves, under 17 in. diameter, were *the ordinary slide*-valves with double brass facings.

*The ordinary* fire-cocks in Glasgow, in 1863, were of *brass, upon the principle* of the common ground-cock, with

the water admitted to the inside of the hollow plug. In addition to these, there were also a number of Bateman and

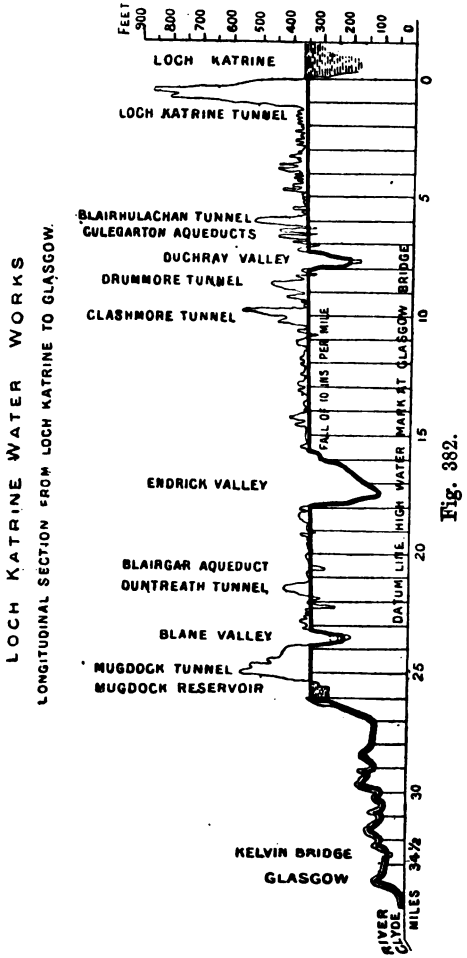



Fig. 382.

*Moore's* fire-cocks, serving as cleansing-cocks and air-valves *The* water-meters used are Kennedy's patent. Previo

to 1848 such water-measurers were unknown, but the Gorbals Water Company's 1848 competition brought out several.

The two diagrams, Figs. 381 and 382, show the course or line of the water conduit from Loch Katrine to Glasgow. The general public in Glasgow have no idea of the many downs and ups the water they drink has had before it reaches them. Very few plumbers, even as yet, have any definite knowledge of the subject, so it is hoped the information here given will be both interesting and useful.*

For some time back additional works have been going on to increase the amount of water deliverable to Glasgow from Loch Katrine. These involve a new aqueduct from Loch Katrine to a new service reservoir at Craigmaddie. This new aqueduct is about 23½ miles long. It will be able to supply 70,000,000 gallons of water per day, which added to that from the present aqueduct of 40,000,000 gallons per day, will bring up the total supply to the service reservoirs to 110,000,000 gallons per day, of which 100,000,000 will be available for the city.

The new reservoir at Craigmaddie has a water service of 86¼ acres, and will contain 700,000,000 gallons of water—equal to a supply to the city at the rate of 40,000,000 gallons per day for 17½ days, in addition to the 12½ days' supply the present Mugdock reservoir contains.

The inlet and outlet works are to be so arranged that either or both reservoirs may be used to supply the city.

Two 36-in. pipes are being laid from the Craigmaddie reservoir. Eventually, when needed, there will be four. These works will cost about £1,200,000 sterling.

There are four 36-in. pipes from the Mugdock reservoir at present. One goes towards Partick, another comes to Glasgow by the Great Western Road, and one by the new City Road. There is a junction valve in connection with these two at St. George's Road. The other pipe comes in by the Garscube Road.

Glasgow Water-Works Accounts.—The accounts of Glasgow Corporation Water-Works show that the revenue for the year 1893-94 amounted to £177,950 18s. 3d.—an increase on the previous year of £6,083 4s. 9d. For the

* *Various systems* of jointing the large cast-iron pipes were tried. *At first spigot* and socket joints stuffed with yarn and run with lead *were used. Then* for the last 20 years turned and bored joints were *used. Recently* mild steel collar joints have been in use.

same period the expenditure was £135,061 14s. 8d.—a decrease of £2,122 2s. 10d. The interest paid last year on capital expended on new works amounted to £88,867 1s. 1d. The sum expended on new works and added to the capital account was £192,354, and *there has now been spent on Craigmaddie reservoir and the new aqueduct works* £880,000. The amount paid over to the sinking fund and applied in the redemption of debt was £39,611. The capital account now amounts to £3,174,672, and the sinking fund to £730,582. On an average about 46½ million gallons are used per day. About eight miles of the new aqueduct are completed, and are now in use, with the result that 4½ million gallons per day of additional water is brought from Loch Katrine. It is expected that other 8½ miles of the new aqueduct will be finished in about six months. The earthwork of the new Craigmaddie reservoir will be finished next summer.* Two additional 36-in. mains are being laid between Mugdock and the city. The work will be finished early next year. One of the mains is intended to supply the high ground at Springburn. The hydraulic works for supplying water for working hoists and for power generally are making good progress, and the pipes are being laid down through the streets. The works will be in operation by May of next year.†

* On March 26, 1895, Mr. James M. Gale, M.Inst.C.E., the Engineer to the Glasgow Water Commissioners, read an interesting paper "On the Extension of the Loch Katrine Water-Works" to the Institution of Engineers and Shipbuilders in Scotland, giving information up to date. The experience derived from the older works shows the bridges to be the weakest part of the aqueduct, variations in the temperature of the atmosphere having had a bad effect upon them. Severe frost sometimes lifts the upper courses of masonry from their beds, causing extensive leakages, so that linings of cast-iron plates had to be used. Mr. Gale says the highly-eulogised Roman aqueducts would seem to have always been in a chronic state of disrepair. In the new work, therefore, tunnels have been used in place of exposed bridges, in order to keep the water-channel as much as possible underground and free from the action of the atmosphere.

† *Glasgow Herald*, September 28, 1894.

## CHAPTER XXV.

### PUMPS.

A SIMPLE pump is the common lift-pump shown in Fig. 383. In this case, the pump-head B is of lead, and is securely fastened by screws or bolts to the wooden plank C. D is a 3-in. copper chamber, in which the valves work. E is a lead pipe, 1½ in. in diameter internally, and from 16 lb. to 22 lb. per yard, according to the depth of the well. F is the handle, which, being pressed down, as is supposed to be the case in this sketch, pulls up the working-box G, and so opens the lower, or under valve H, as shown. The cause of the lower vale H opening when the working-box G is pulled up, is the pressure of the atmosphere upon the surface of the water in the well into which the lead tail-pipe E dips.

Fig. 383.

When G, Fig. 383, is pulled up from H, it tends to form a vacuum; but instead, the valve at H opens, and first allows any air which may be in the pipe E to escape upwards, above H, and fill the space between G and H. The handle being raised, pushes the working-box or bucket G, down again towards H, but so soon as this is attempted to be done, the valve at H closes—in fact, the valve at H closes whenever the upward motion of G stops—and the valve at G opens, thus allowing whatever there is between G and H to get above G, and so, with several moves of the handle F, the air between G and the surface of the water in the well is all taken out, the water following up after it; and so, the *working* of the handle being continued, the water rises up *E, past H and G,* into the head B, and thence out by the *spout, and continues* so to run as long as the pump is *worked and the* supply of water in the well continues.

*It will be observed,* of course, that the valves at G and H

both open upwards. The top of the copper chamber D stands up about a quarter of an inch in the bottom of the lead head B, so that any sand or such like coming up the chamber D may not fall back again into it. The greatest depth from which such a pump, as in Fig. 383, will properly lift the water, is about 28 ft. below the valves in chamber D. The reason of this is that the power which forces the water up the tail-pipe E during the working of the pump can only do so to the extent of its strength. Now, as the greatest strength of this "power," viz., the pressure of the atmosphere, is only equal to the height of a column of water 30 to 34 ft. high, it follows that, allowing a margin for the working of the valves, about 28 ft. is the greatest depth from which the pump will work freely.

Another point for consideration when fixing up the pump is the difference between the well when full and empty. The mean pressure of the atmosphere is about 14 lbs. to the square inch, so a column of water about 32 ft. high, and equal in sectional area to one square inch, will weigh about 14 lbs., and thus the pressure of the atmosphere and the column of water counterbalance each other. From this we see that if we know the number of pounds of pressure on the square inch, we may get the number of feet of water by multiplying by 2¼, or 2 2-7ths, thus: 14 lbs. by 2 2-7ths = 32 ft., which comes pretty near it.

Mercury, again, is about thirteen times heavier than water, and as was discovered by Torricelli in A.D. 1643, a column of mercury about 29 in. or 30 in. high, according to the density of the air at the time, counterbalances the pressure of the atmosphere, and so 29½ in. for mercury × 13 for water again gives 32 ft. It must be understood that it is only at the surface of the earth that the pressure is about 14 lbs., or equal to 32 ft. of water; as we ascend, the pressure gets less.

Previous to the time of Galileo, it does not appear that any philosopher considered the weight of the atmosphere had anything to do with natural phenomena.* The inventor of the air-pump was Otto Guericke, in or about A.D. 1650.

I may here explain Torricelli's experiment:—Take a glass tube, hermetically sealed at the one end, and say ¼ in. in

* *See page 3 of* "Ventilation," No. 271 of Weale's series. Air *pressure, by pumping* air upon the surface of the liquid in the casks, *is used to press* beer, &c., up from cellars to the draw-off taps above.

diameter internally, and 3 ft. long. Fill it quite full of mercury, then stop up the outlet firmly with the finger, then turn up the tube and insert its lower end into a vessel containing mercury, as per Fig. 384. When the finger is removed the mercury will be seen to sink down a little in the tube, until it stands about 30 in. higher than the surface of the mercury in the vessel. This perpendicular column of mercury, 30 in. high, is prevented from falling down into the vessel by the pressure or counterbalancing weight of the atmosphere.

Fig. 384.

The notion that "nature abhors a vacuum," or that she is always able to prevent one being formed, would therefore appear to be wrong, for a vacuum exists inside the glass tube above the 30 in. of mercury. The weight of the atmosphere near the surface of the earth is about 1¼ oz. to the cubic foot, while the weight of a cubic foot of water at its maximum density —about 39·1° Fahrenheit—is about 62½ lbs., or 1,000 ounces; the water, in this case, is therefore 800 times heavier than the air.* Mercury, again, is 10,000 times heavier than the air.

When a pump is newly finished, or has been sometime unwrought, and no water in the chamber, it is sometimes difficult to start it at first. By pouring a little water, however, into the chamber, it is soon all right. This water softens the leather of the valves—when they are of leather —and also prevents the air which passes up through H from getting back again.

Another style of pump with copper barrel and lead head is the square lead-headed pump in square wooden case. This style of pump is largely used, the wooden case or box in which it is placed serving to protect it. The pump is much the same as in Fig. 383, only as the head in this case is square, and is placed in a case, it is supported and held fast by wooden fillets. In the upper portion of front of case is a door with lock to gain easy access to the interior.

Fig. 385 is an enlarged view of the 3-in. working-box, or *bucket, shown at* G, in Fig. 383. I, Fig. 385, is piece of

* *In water the chemical* combination of the oxygen and hydrogen *gases* $OH_2$ *forms the* new substance or liquid we call "water." In *the atmosphere, however,* the oxygen and the nitrogen are only mechanically mixed.

good stout leather, ¼ in. thick, and 1½ in. broad, put round the top of the wooden working-box, the rough or flesh side out; it is secured by ¾-in. copper tacks, as shown. The leather is pared off a little where the tacks are put in, so that when driven in the heads of the tacks may not come in contact with the inside of the chamber. The two ends of the leather are made to overlap each other a little, both ends, however, being pared down, so as not to increase the thickness. J, Fig. 385, is the bottom of the iron pump-rod, divided into two prongs, the prongs passing down through the wooden box, and being secured at the bottom by means of rivets or nuts.

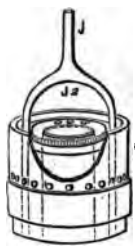


Fig. 385.

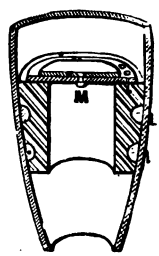


Fig. 386.

Fig. 386 is view of the wooden under-box and valve shown *in situ* at H, Fig. 383. This under-box is tapered to suit the taper in the bottom of the copper chamber. To fix it in its place, hemp dipped in melted rosin and grease is wrapped round it at the grooves shown at L L, Fig. 386.

When the plumber afterwards wishes to remove the under-box, he heats up the outside of the bottom of the copper chamber by setting fire, say, to a few wood shavings, which, melting the rosin and grease, releases the box. M, Fig. 386, is the clack-valve, formed of a piece of leather about ¼ in. thick. Above the leather, and attached to it, as shown, is a piece of cast lead about ⅜ in. thick, and about 1¾ in. long, and 1¾ in. broad.

Fig. 386 is a perpendicular sectional view. Sometimes the under-box is fitted with a bent piece of rod iron, in shape as per J², Fig. 385, minus the upper part J, for the purpose of drawing it out. Fig. 387 *is an iron* pump, working upon the *same principle* as Fig. 383; its chamber may either be its *own iron, properly* bored, or a copper one may be inserted

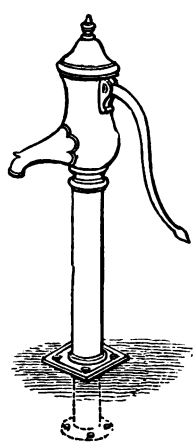


Fig. 387.

Fig. 388 is a 3-in. brass lift-and-force pump, mounted on cast-iron frame, very suitable for a country house, where it is wished to pump the water from a well under the ground up to a cistern in the garret or uppermost flat, for distribution through the house. It may be had, of course, of different sizes, either smaller or larger than 3 in.; but 3 in. is a good working size. The interior diameter of the chamber of the pump being 3 in., the interior diameter of the tail-pipe N, Fig. 388, and of the rising main, O, will be $1\frac{1}{2}$ in. The under-box in this case may be either of the style shown in Fig. 386, or it may be made of brass, in place of wood. The working-box, however, is generally of brass, with cup leather, and may have either a clack-valve or a spindle-valve. Another valve is placed upon the rising main at P, Fig. 388, which valve at P, opening upwards, keeps all it gets and helps to prevent *the weight of water* in the rising main or ascension-pipe O, *from pressing continually* upon the stuffing-box Q, or other *parts of the pump* below it.

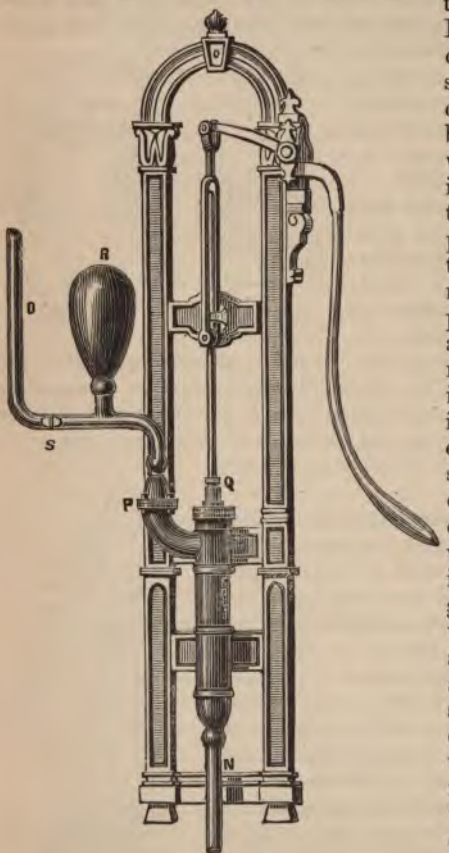



Fig. 388.

*The reason why* I have mentioned $1\frac{1}{2}$-in. pipe for the 3-in.

pump is because a larger size is unnecessary, and to put in a smaller size does not give either the pump, or the person who works it, the same fair-play. R, Fig. 388, is a copper air-vessel, about 8 in. across. It is put on as shown (or the rising main may be led out of its top, as per T, Fig. 389), in order to cause the working of the pump to be easier, and its delivery more regular; by its aid the water in the rising main—in place of being jerked along it every time the working-box is raised—is made to flow continuously, the elasticity of the air in the air-vessel preventing this jerking.

When the well is both deep, and the tail-pipe of the pump also goes a considerable distance horizontally, an extra valve is often put in upon the tail-pipe above the water level; another plan sometimes adopted is to put on an air-vessel upon the tail-pipe, as close as convenient to the under valve of the pump. As the cistern to which the water is being pumped up is generally out of sight, and at a considerable distance perhaps from the pump, some means should be taken to inform the party pumping when the cistern is full. For this purpose a $\frac{1}{2}$-in. or $\frac{3}{4}$-in. *warning-pipe* is led from the cistern $\frac{1}{2}$ in. below the overflow-pipe, to the vicinity of the pump, so that when the cistern is full, the water from this warning-pipe tells the person at pump when to stop.

In order to keep small stones and stuff in well from getting into the tail-pipe, the bottom of the end which goes down into the well is closed up and a few inches, more or less, as the case may be, from its bottom, the lead tail-pipe is bored full of small holes about $\frac{1}{4}$ in. or $\frac{3}{8}$ in. in diameter. A sufficient number must be made to allow the water to fill the pipe quite freely. In place of boring the pipe itself a round perforated strainer, whose diameter will be about double or treble that of the pipe, may be put on. This strainer is what is used when the tail-pipe is iron. As the areas of circles are to one another as the squares of their diameters, it follows that, allowing a margin for the extra friction on the smaller holes, it will take fully forty $\frac{1}{4}$-in. holes, or about twenty $\frac{3}{8}$-in. holes, to supply a $1\frac{1}{2}$-in. pipe properly. In *practice it is better* to err upon the safe side by putting in *a few extra than* too few.

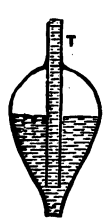


Fig. 389.

*It is a common* and often useful practice to put on a $\frac{3}{4}$-i

bib-crane, say a good lever-handled stuffing nose-cock, or a screw-down crane, at S, Fig. 388. By this means water can be drawn direct from the pump.

In giving a partial reproduction of Fig. 388 in the June, 1875, number of the *Manufacturer and Builder*, published in New York, I observe the editor stating that instead of using a large cistern in the upper flat from which to draw off the water, it has of late become customary in New York for the pump to be placed in the lower flat, while the handle is situated in an upper flat, a long piston-rod, with the requisite guides, being carried up from the pump to the handle. The rising main pipe Q being carried up to near the pump handle, and a crane put on, the water is drawn as directly and as cool as possible from the well.

As the tail-pipe of the pump may hang down perpendicularly into the well about 30 ft., it is necessary to support it properly. This can be done by fixing up two strong planks horizontally inside the well, each end of plank being thrust into a hole cut for it in each side of the well. One plank may be put in about 10 ft. down and the other about 20 ft. down. Holes are cut through the boards for the tail-pipe to pass through, and with the help of a good lead flange about 9 in. in diameter, which rests on the board, and which is soldered to the lead tail-pipe, the said tail-pipe is thus supported.

Regarding working down a deep well, it is sometimes dangerous to go down a well which has been some time closed up. Before doing so the plumber ought first to lower down a candle and see if it will continue burning all the way to the bottom, or to the surface of the water in the well. If it goes out, independent of falling into the water, or a drop of water, &c., falling upon it, then the air is foul, and it would be at the risk of his life and a piece of supreme foolishness for any one to go down (unless with diving-belt apparatus) until the well has been left open some time and the air purified so that the candle will continue to burn properly and the man to breathe freely and safely. Dashing down several buckets of clean water helps to improve the air in a well. Or for a dangerous well the *following plan* may be adopted:—Take as many feet as *required of 3-in.* zinc or other handy pipe, and attach a *wide mouthpiece* at its bottom. To this mouthpiece (right *in centre) suspend* a lighted candle. When this lighted

candle is lowered with the pipe, the flame causes a current upwards of the foul air, upon which a down current of fresh air sets in to supply the place of the foul. The working-boxes or buckets of the foregoing pumps are pierced in the centre, and with valves in them.

Another style of pump is that shown in Fig. 390—which gives sectional view of a plumber's hand force-pump—where, instead of the working-box or bucket, a solid plunger is used. When the plunger rises the water follows it, the under-valve opening up and allowing it to do so. When the plunger is pushed down the lower valve shuts, and the water rushes up the rising-main or outlet pipe, forcing open the rising-main valve, which keeps all it gets.

The hand force-pump shown in Fig. 390 is generally used by plumbers to clear service-pipes which have got choked up. The small stop crane, with coupling, shown on outlet pipe (which in this case is flexible, being made of india-rubber or leather) of Fig. 390 is put there for a different purpose. In this case, instead of being used to pump water, it may be made to pump air, serving as a first-class testing-pump for the gas pipes in, say, a large newly-erected house. The *modus operandi* is to close up the ends of all the pipes, and the small stop-cock shown in Fig. 390 being connected with the main gaspipe, the pump is set agoing.

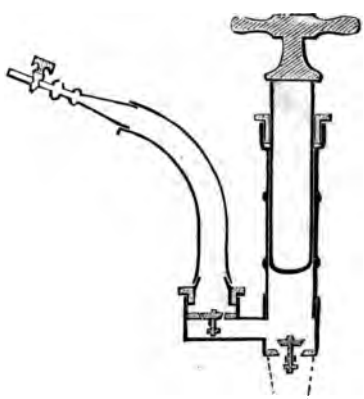


Fig. 390.

If there are many large escapes in the gaspipes, then the air will rush out at the holes, and these holes, or improper connections, can be traced out. If the pipes be all right, this is proved by pumping air into them until a certain pressure is put on—not too much; then the stop-cock being *shut, the pump* is uncoupled from it, and in a few minutes, *the stop-cock* being opened, the confined air rushes out with *some force* and noise. If, however, there be a small escape

this is shown by the air coming out with little force, or, sufficient time being allowed, no air coming out at all. When obtainable a pressure-indicator may be used.

I have said that a pump will not lift the water from a greater depth than about 30 ft., yet, as many wells are several times 30 ft. deep, it is necessary to lift the water from that depth by some means or other. In this case, by lowering the pump down into the well until it comes to about 28 ft or somewhat less from the surface of the water, the water may be sent up to the required height. To work the pump or pumps in this situation long iron rods are required. In very deep mines a series of pumps is used. The lowest pump raises the water so far and discharges it into a small cistern ; into this cistern the tail-pipe or suction-tube of the pump next above dips, which pump raises the water into another cistern, and so on until the surface of the earth is reached and the desired height for the outflow attained. One long rod, or "spear," set in motion by a steam-engine and the necessary machinery above, is sufficient to set all the various piston-rods of the different pumps working.

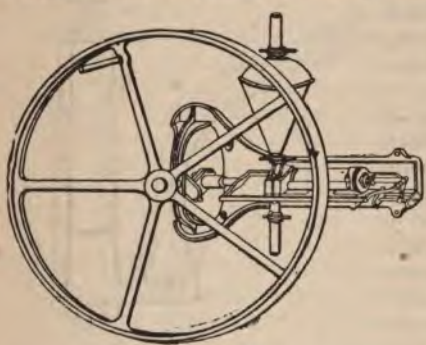


Fig. 391.

Fig. 391 is sketch of Messrs. J. and A. Law's (of Glasgow) double-action rotary pump, with copper air-vessel, brass barrels and connections, on an iron plate for fixing to a wall. One of these was fitted up by the writer to force the water up to the cistern at the top of the house at Dallam Tower.

I cannot enumerate all the various varieties of pumps and the different styles of working them, by means of levers, eccentrics, cranks, and wheels, for their name is legion ; but *what I have said* will serve to show the principle upon *which pumps* work.

## CHAPTER XXVI.

### THE HYDRAULIC RAM.

THERE is another interesting and useful machine for raising water which I may shortly describe, viz., the hydraulic ram. This instrument is self-acting, and when once properly set agoing it will go on working away day and night without intermission for an indefinite period. Its action is due to the inertia of a *moving* body of water.

In Fig. 392, U is the source of the water supply, V the position of the ram, say 100 ft. (it may be somewhat less or much more, according to site, only the distance must not be too little, or the ram refuses to work) from U, and 10 ft. lower. W is the house, say 300 ft. or yards from ram, and its uppermost flat, where the cistern is, about 90 ft. higher than ram; X is the supply-pipe to ram, and Y the rising-main from the ram to the house. Z is the pipe or drain conveying away the waste water. Fig. 392, therefore, shows the position of the ram relative to its source of supply (which may be either a running stream or a lake, &c.) and point of delivery.

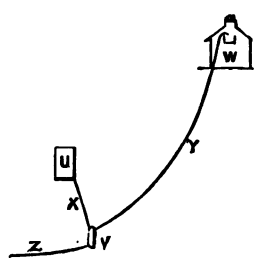


Fig. 392.

In Fig. 393 an idea of the ram itself is given. At A the water enters, and rushing along, it gets exit at B; but, under B, we see the valve C; the water rushing along comes into contact with C, and exerting its power upon it, suddenly lifts it up or closes it. This closing of C so suddenly, tends *to at once arrest* the motion of the water in the pipe A, *which water* had a certain amount of momentum in it

corresponding to its height and the size of the pipe. Owing to its possessing this momentum, the water, so soon as it has shut the valve C, immediately opens or forces up the valve D, and so much of it passes through and gets above D. This done, the valve D closes, keeping all it gets. The valve C now again falls, simply owing to its own weight, and the water rushes out as before; but again C is carried with it, which closing causes the water to again open D, and fill the air-vessel E, so far.

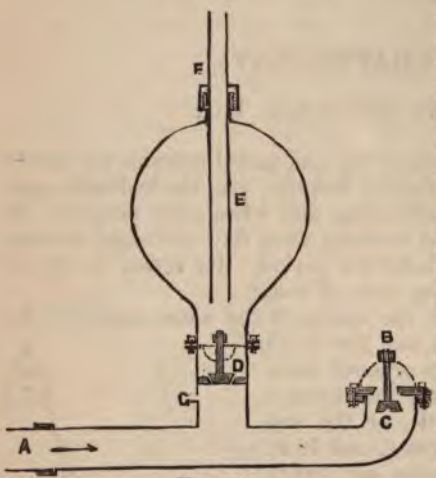


Fig. 393.

From this alternate closing or working of C and D, it will be seen that in a short time a considerable quantity of water will have passed D; this water, therefore, after it has filled E so far, compressing the air in it—which air acts as a sort of spring—flows up the rising main F towards the receptacle for it at the house.

If we suppose the internal diameter of the pipe at A to be 2 in., then the internal diameter of the pipe at F may be 1 in., and the quantity of water which a ram of this size will supply may be about one thousand gallons, more or less, according to circumstances, in the twenty-four hours. Rams, however, can be had of various sizes, from one with $1\frac{1}{2}$-in. inlet and $\frac{3}{4}$-in. outlet, to one with 4-in. inlet and 2-in. outlet, the latter throwing up about five thousand gallons a day. Some plumbers have fitted up their rams with 3-in. inlet pipe and only 1-in. outlet; this causes greater friction *in the* ascension pipe, and I also fear more noise. Many *consider the* proportion of the fall to the rise in rams should *not exceed 1 to 10*; thus if the fall of water to ram—taken *perpendicularly*—be 7 ft., then the height to which the

water will be sent above the ram will be about 70 ft. If the fall be 20 ft., then the rise may be as much as 200 ft. and so on.* The quantity saved of the water passing through the ram may be taken at about one-tenth; thus for every ten gallons that enter the ram, one gallon is sent on to the cistern or reservoir, in or near the house. G, Fig. 393, is the snifle valve, a section of which is shown in Fig. 394. This Fig. 394 is a brass bolt with hole drilled up its centre as shown, for the valve to work forwards and backwards in. H is the end towards the interior of the ram, I the outlet, which, as will be seen, is very small, just large enough to admit the point of a pin. The use of this small valve to the ram may be said to be somewhat analogous to the use of a man's nostrils to him. The man may speak, although his nostrils are stopped up, as when he has a cold, but he will speak all the better when they are clear.

After having been some time in use it has often happened

* In the *Engineer* for January 7th, 1876, a correspondent states that with a fall of 20 ft. the water was sent up 160 ft. above the ram, the quantity lifted being 20 gallons per minute. The length of the discharge pipe was 700 ft.

In the same journal again, but under date January 28th, 1876, Mr. William W. Fyfe, of Aberdeen, gives the following table of results, as obtained by rams made and fitted up by his firm:—

| | Fall in Feet. | Quantity in Gallons per Minute Used. | Quantity in Gallons per Minute Lifted. | Height of Delivery. | Percentage of Duty. | Proportion of Lift to Fall. |
|---|---|---|---|---|---|---|
| 1 | 8 | 5·949 | 0·669 | 66 | 0·927 | 8·25 |
| 2 | 7 | 9·47 | 0·27 | 200 | 0·81 | 28·57 |
| 3 | 5·5 | 1·2 | 0·214 | 24·2 | 0·78 | 4·4 |
| 4 | 4 | 42 | 1·1 | 96 | 0·625 | 24 |
| 5 | 1·16 | .. | ·5 | 34 | .. | 29·14 |
| 6 | 0·75 | .. | ·15 | 34 | .. | 45·33 |
| 7 | 6 | 42 | 1·2 | 120 | 0·57 | 20 |
| 8 | 10·5 | 9·297 | ·537 | 96 | 0·537 | 9·14 |

The falls were so low, in cases 5 and 6, that the waste could not be measured, and 7 and 8 are pumping rams, lifting pure spring water while being driven by impure streams, which, of course, require a greater expense of power.

*John Blake,* hydraulic engineer, Accrington, Lancashire, deals largely in rams.

that the air-vessel of a pump, or ram, becomes useless on account of the air at first contained in it having somehow vanished, either the water having absorbed it, or else the air has slowly passed through the water as does sewage gas through the water in the siphon-trap of a water-closet. Or, again, *a small hole* somewhere may be the cause. To provide for this some parties attach a small stop-cock to the air-vessel near the top, by means of which air can be admitted when necessary.

Professor F. E. Sweet suggests another remedy, viz., to

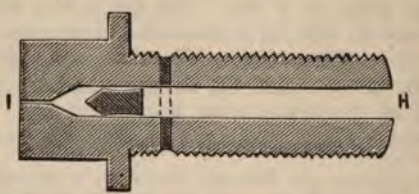



Fig. 394.

place in the air-vessel some sperm oil, the floating of which on the surface of the water prevents contact with the air and the water, and thereby acts as a sort of check-valve to keep the air imprisoned. I have as yet had no experience of the working of this, and merely mention it.

Mr. McTear, of St. Rollox Chemical Works, made some experiments for me as to how this oil would act in keeping back gases from passing through water-locked siphon-traps, but it was found to be useless for that purpose. A mineral oil such as heavy paraffine, non-inflammable at less than about 400 degrees, would be more suitable where it could be applied. Mr. Townsend has long used this latter in keeping down bad smell at the urinals; the paraffine being made to float on the top of the urine.

## CHAPTER XXVII.

### The Siphon.

Siphons are used to transfer various liquids from one vessel or cistern to another, and, on a large scale, to empty lochs or pits of water wherever the water at the outflow end can be discharged at a sufficiently lower level than the water to be emptied.

The power or force which causes a siphon to work is the pressure of the atmosphere upon the surface of the water on the inlet side, combined with the greater weight of water at the outlet. Hence the greatest height over which a siphon will lift the water will be about thirty feet By a simple experiment it is easy to show the action of the siphon. K, Fig. 395, is the vessel to be emptied, L the vessel to be filled. M is the siphon, and N the tube to charge the siphon by. O is a short pipe through which liquids or air may be admitted into the close vessel K. K being full and L empty, the lower end of the siphon is either closed up with the hand or by shutting the stop-cock—if one be on upon the end next L—and the mouth being applied to the small pipe at N, the air is all sucked out of the siphon M until the water begins to come into the mouth, the hand and mouth are then withdrawn and the water from K passes up and down M into L. During the rush-off of the water the flow can be stopped at will by simply pressing the finger or hand closely upon the mouth of the pipe at O. In Fig. 395, the top of the round vessel

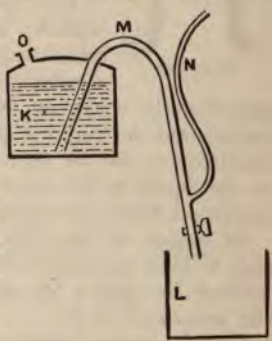


Fig. 395.

K is shown as arched; were it made quite flat on top, and of sheet tin not extra strong, then upon the rush-off of the water being suddenly suspended by stopping up O, the top of the vessel would collapse or fall in so far owing to the pressure of the atmosphere upon it.

In Fig. 395 the pipe N is shown as long as the siphon, but it may be used much shorter, and with a small stop-cock upon it at its junction with the lower end of the siphon. The discharge would be greater with N shut.

Another way to charge and start a siphon where the pipe is large, is to fix a stop-cock or sluice-valve on each end, and a 2-in. (or larger) brass trap-screw at the highest part of the siphon. The two cocks being shut, the cover of the trap-screw is taken off and water poured in until the siphon is quite full and all the air out. The trap-screw cover being put on again, and screwed up tightly, the two cocks are opened simultaneously and the water flows. In other cases, again, siphons are charged with a force-pump.

Fig. 396.

Fig. 396 is known as the Wirtemberg siphon; when once filled with the liquid it remains filled so long as it is held perpendicularly. When one end of this siphon is immersed in water or wine, &c., then the balance is disturbed, and the liquid in the end not immersed being heavier relatively to the air than the liquid in the immersed end is to the liquid in the vessel, the effect is that the liquid to be drawn off flows out at the end not immersed.

In regard to Fig. 395, it must be understood that the pipe N does not necessarily form a part of the siphon, for without the pipe N the siphon M can be charged by sucking the lower end of M.

Certain natural phenomena and also some curious tricks are produced by the action of the siphon. Intermittent springs are examples of the former, and the "vase of Tantalus" is a specimen of the latter.

I observed in opening that the greatest height over which a siphon will lift the water is about 30 ft. That refers, of course, to the height above the surface of the water to be lifted. If, however, for some particular reason the siphon has to dip down, or traverse a valley before rising over the hill, then the perpendicular height from the bottom of the valley to the top of the hill might be much more than 30 ft.

## CHAPTER XXVIII.

### Flow of Water through Pipes.

It sometimes happens that after a plumber has put his water-supply pipes, say, from one cistern to another, as in Fig. 397, or from a cistern to a kitchen-sink or bath, that the water refuses to flow from the one cistern to the other, or from the cistern to the water-tap. Of course this may occur owing to the pipe having got choked up with some foreign substance, such as rags, paper, wood, or lime, &c., or owing to the worthy plumber having made a "solid joint," but that is not what I wish to refer to here.

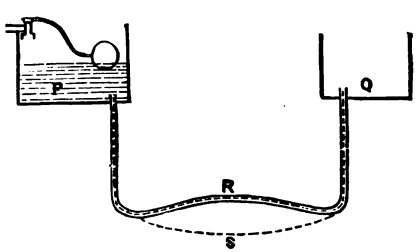


Fig. 397.

In the cases I wish to speak of we shall suppose that no water has yet been put into the cisterns whatever, and that the connecting-pipe between the two cisterns is so clear that it can be blown through quite easily. The water being let on to the cistern P, Fig. 397, and P filled, it is expected that upon looking into the other cistern Q that it will also be filled, or at least be filling up as quickly as possible; instead of that, however, the cistern Q is perhaps found to be empty. The reason for this is that the pipe R connecting the two cisterns has not been put in properly. Instead of that portion of it which goes horizontally being put in quite level, or, if off the level, put in as per dotted line S, Fig. 397, with a valley in the centre, so that no air could

lodge in it, the pipe has been put in with a rise in the centre, as shown at R, Fig. 397, and the consequence is that when the water runs down from P a portion of it gets over the ridge at R and fills up the pipe beyond so far; this, however, imprisons the air at R, which to the extent of a glassful or a tumblerful or so (according to the size of the pipe) cannot get away, being jammed in betwixt the water upon each side of it, upon which it floats. If the cistern P were a considerable height above the cistern Q, then the pressure of the water from P might force the air before it. In this case, however, both cisterns are on the same level, and the pressure at R only a few feet—about 5 or 7 as the case may be.

To get the water to run the plumber may adopt either of the following three courses most suitable in the circumstances:—First, if the position of the pipe will allow of it, he may press down the pipe at R, doing away with the ridge or rise there, whereupon the air will of its own accord rise up through the interior of the pipe and the water begin to flow into Q.

Second, he may apply a hand force-pump (see Fig. 390) to the mouth of the pipe in P, and by pumping in water force the air out at the end of the pipe at Q, and the air being once out the water soon rises up into Q and fills it.

Third, he may pierce the pipe at the highest part of the rise at R with a nail, and through the small hole thus made the imprisoned air will come blowing out; so soon as that air is out the water immediately flows onwards and upwards into Q until the water in the cistern Q stands at the same level as the water in P. This would be the case supposing the distance between the two cisterns P and Q was several hundred yards and the internal diameter of the pipe only 1 in. or even less; but, of course, the greater the distance and the smaller the pipe the slower the flow, as the friction of water in motion through pipes is very considerable. This friction takes place against the sides of the pipes, the friction of the particles of water amongst themselves being very little.

I have said that the plumber's "third" plan would be to pierce the pipe with a nail; this is a very common thing *for plumbers to do* with leaden pipes when they wish to let *out either air* or water, and after the hole—which is only

sent through one side of the pipe—has served its purpose it is plugged up with a small piece of good wood, say pine, and the plug being cut off flush the lead is riveted over it to keep it in.

It occasionally happens that the plumber has to provide for the continual gathering of air in a pipe whenever the cistern happens to get empty.

In this latter case he may either put on a small stop-cock (a ⅜-in. gas stop-cock often serves the purpose), to open and shut with the hand whenever necessary, as at T, Fig. 398, or instead of the stop-cock an air-pipe may be put on, as at U, Fig. 398, the top of said air-pipe being carried up higher than the top of the cistern so that no water may come out when the draw-off cock is shut suddenly. The reason why a small stop-cock or an air-pipe is spoken of as being put on at T, Fig. 398, is because the pipe at T is higher than at V, and consequently air lodges at T; were T lower than V and the pipe between T and V straight, no air would lodge.

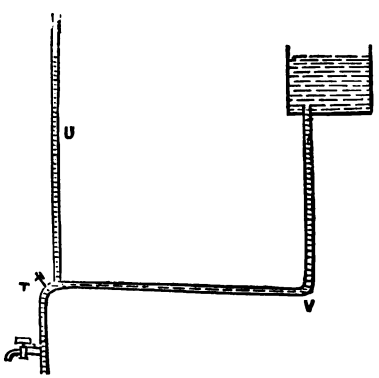


Fig. 398.

It was mentioned above that the friction of water in motion through pipes was very considerable, and in consequence the flow of the water was retarded very much thereby. This effect of the friction is known as the "loss of head." In connection with this, and before proceeding further with my own remarks, I may here quote the following interesting observations which formed part of a leading article in the *Building News* of date December 4th, 1874:—

"When water is conveyed from one tank or reservoir to another, by means of a long pipe, there is a certain amount of resistance offered to it by the surface of the pipe; this resistance is proportional to the surface of the pipe, and will, therefore, be greater for a small than a large pipe; it is also very nearly proportional to the square of the velocity

at which the water is moving. The retardation caused by this resistance prevents water from rising to the same height again after passing through a long pipe,* and occasions what is termed a *loss of head*, the head of water being the height of the surface of the reservoirs above the orifice of discharge at the lower end of the pipe.

"To find the velocity of discharge from a pipe, multiply the head by the diameter of the pipe, and divide by its length (all in feet), then multiply the square root of this quantity by the constant number of 50, and the result is the velocity in feet per second; if this velocity is multiplied by the area of section of the pipe (also in feet), we obtain the number of cubic feet discharged in a second of time; and this multiplied by 6¼, gives the number of gallons. For example, if the head is 32 ft., the diameter of the pipe ½ ft., and its length 100 ft., the velocity of discharge will be 20 ft. per second, and the area of section being one-fifth of a foot, the discharge will be 5 cubic feet, or 25 gals. per second.

"We have here supposed the pipe to be quite straight, without curves or bends, but as these are usually of frequent occurrence in pipes of considerable length, a much greater amount of retardation takes place, and the velocity of discharge decreased thereby. If the change of direction of a pipe is made with a sharp elbow, the retardation is much greater than with a rounded turn; when the angle of deviation is 40°, with a sharp elbow, the loss of head due to the turn is one-seventh of the head of water due to the velocity at that point. For an angle of 60°, the loss is rather more than one-third; and for 90° the loss is nearly equal to the head itself, or the water is momentarily brought nearly to a standstill. In general, however, the change of direction is made with a circular bend, and the larger the radius of the bend the less the resistance caused by it: thus, if the radius of the bend is five times that of the pipe, the loss of head in a deviation of 40° is only one thirty-second; where the angle is 60° it is one twenty-first, and for 90° it is one-fourteenth."

In order to afford some further explanation of the practical working of this, I proceed to explain some experiments *I made. I took* a lead pipe ¾ in. in diameter internally and *50 ft. long.* The end at which the water was poured in was

* *In connection with this point, see remarks on Fig. 400.*

bent up 6 ft. high, and the outlet end only 1 ft. high; the height of the inlet above the outlet being thus 5 ft. When the water flowed full bore out of the lower end it only rose up into the air about 3 in. high, thus showing a loss of head of about 4 ft. 9 in.; when, however, the orifice was contracted to ¼ in. in diameter, then the water spouted up into the air about 3 ft. high above the orifice. The explanation of this latter result is that for the amount of water emitted from the contracted orifice there was a proportionately less retardation by friction than when the water spouted out full bore from the uncontracted pipe.

In another experiment I took a small gas pipe of only ¼ in. bore and 72 ft. long. I joined it at the one end to a small cistern, as per W, Fig. 399. The top of this cistern was 3 ft. 6 in. higher than the orifice of the other end of the pipe, which other end was bent up as shown at X, Fig 399, about 6 in. above the ground. The length of the horizontal portion of the pipe lying along the ground was, therefore, about 68 ft. Water was poured into the cistern at W, and at first it ran away very freely; but latterly more slowly. I considered the outflow too little, and believed air in the pipe to be the impeding cause. I, therefore, put my mouth to the orifice at X, and blew in as hard as possible, trying to blow the air out at the other end; but it was no use, the 3 ft. 6 in. of pressure at the cistern end being too much, it seemed, to blow against. I, therefore, temporarily raised the end of the pipe at X as high as the cistern W, and waited a little, when the water at the end X rose up as high as in W. I then blew into the end X again, when several bubbles of air came up through the water in W. The end of the pipe at X was then lowered down again to its original position, 6 in. above the ground, when, so long as the supply continued at W, the water poured out freely from the orifice at X, coming with such force as to rise up full bore into the air about ½ in. high, as per Y, Fig. 399.

Fig. 399.

*This ½ in. rise* of the water while coming out full bore was *no great height*, yet seeing that the pipe was only ¼ in. bor

and 72 feet long, and the pressure or head of water above the orifice only 3 ft. 6 in., it was pretty good.

I tried how much water came in a given time, and found that it took six minutes to run off one gallon, which was at the rate of 240 gals. a day. From this it will be seen, therefore, that in a ¼-in. pipe, 72 ft. long, with a head in the cistern, above the orifice, of 3 ft. 6 in., the loss of head when the water flowed out full bore was 3 ft. 5½ in.

It must not be supposed, however (and this is a point I wish to draw particular attention to), that this 3 ft. 5½ in. of loss of head at the orifice, as per Y, Fig. 399, means that the water will rise no higher. If any one thinks so, he thinks wrongly; for, in reality, the 3 ft. 5½ in. of loss of head simply means that when coming out full bore out of the orifice the water, in this case, though with a head of 3 ft. 6 in., after passing through a ¼-in. pipe 72 ft. long, comes so slowly that the strength of the current is only able to cause the water to spout up into the air ½ in. high. If, however, the orifice of this ¼-in. pipe be contracted, which I did by squeezing it together with a pair of nippers, then the water spouts up at once to nearly 2 ft. above the orifice, as per Z, Fig. 399.

Further, as showing the loss of head does not mean that water, if properly guided, refuses to rise up to its level after passing through a long pipe, I put another small cistern upon the outlet end of my 72 ft. of ¼-in. pipe, and set it up as per A, Fig. 400, at the same level as the cistern W, Fig. 400. I then poured water into W, and it soon rose up in A to the same height as in W. At least, if there was any slight difference in favour of W, it was so slight that I was unable to detect it.

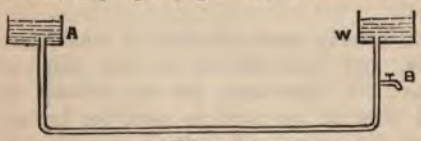


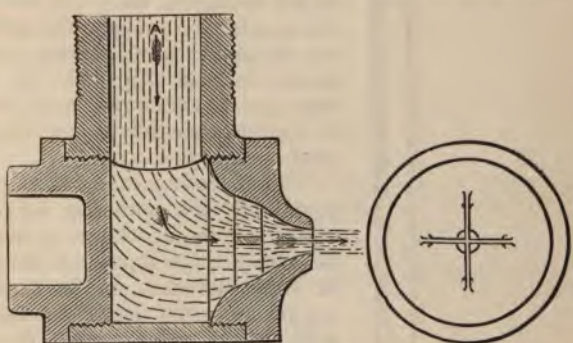
Fig. 400.

If, however, I had either put on a small bib-crane, as at B, Fig. 400, or instead pierced a hole there, then so long as either was open the water would be prevented from rising up into the cistern A. This is one thing that engineers have to consider when drawing out their plans for the water-supply of towns. They must put in pipes of such sufficient size as that, when the near or low end of a street, &c., is drawing off water, sufficient water will be left to supply the other end.

From the foregoing it is apparent that friction retards the flow of water very much, yet, even although the distance between two cisterns be great, if sufficient *time* be allowed, *versus* friction, the water will ultimately stand at the same level in both cisterns, unless, indeed, where the connecting pipe is so small as to allow evaporation to show a fraction of difference in favour of the first cistern. Of course, evaporation may affect the first cistern also; but said first cistern being nearer the fountain-head, or having a larger and quicker supply, evaporation need not be taken into account regarding it.

As an example of the distance which water can flow between cisterns upon the same level, I shall quote the following, kindly given by a correspondent of the *Building News* (p. 139, January 29th, 1875):—

"At Ely station on the G.E.R. is a tank which supplies the engines with water; at Ely Junction is a smaller tank built for the same purpose. The tanks are *on a level*, are



Figs. 401 and 402.

1½ miles apart, and are connected by a 3-in. pipe laid under ground descending from the larger tank, and ascending to the bottom of the smaller one. The water is pumped into the larger tank at the station, and flows into the smaller one at the junction without causing any trouble whatever. . . . . At least 20,000 gallons of water per day are taken from the smaller tank."

*In another* case water was supplied by gravitation through *a pipe a mile* long, and which, in its course, dipped down

to the bottom of an intervening glen. The cistern receiving the water was not much below the level of the fountain-head, and the pipe was not more than an inch bore, and no difficulty was experienced in getting the cistern filled.

I shall close this article upon the Flow of Water with a quotation from a paper read before the Philosophical Society of Glasgow, December 2nd, 1874, by Mr. Alexander Morton, relative to experiments made by him upon *fluid jets and induced currents*. Mr. Morton kindly permitted me to do so.

"The apparatus shown in section by Fig. 401, consists of a simple conoidal nozzle screwed into the body of the inlet or supply-tube, which nozzle, when supplied with a head pressure of water of from 8 to 10 ft., discharged a jet vertically to within 1 ft. of the height of the supply level, when there was little or no rotary motion in the jet on leaving the nozzle. To prevent this revolving motion I used a cross piece, shown in plan, Fig. 402, in the wide end of the nozzle, as I found it almost impossible to get steady results without it.

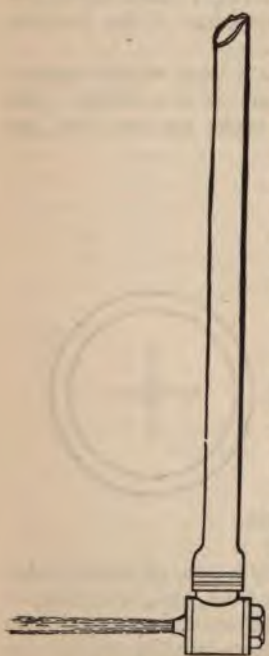


Fig. 403.

"Water falling freely through a tube, although perfectly straight and free from any knees or bends, has always an inclination to revolve in some direction in its onward course, and often leaves the nozzle with such a velocity that the jet becomes broken into spray at a short distance from it. Certain knees and bends so increase the revolving motion, that the centrifugal force on issuing from the nozzle may nearly equal the impelling forward force of the jet; hence the necessity of a 'cross piece' in *every experiment*, as steadiness and accuracy are of the *greatest importance* in obtaining definite results. With *the apparatus, Fig.* 401, suspended by a flexible india-

rubber tube, as shown by Fig. 403, there action of the jet may be approximately obtained by measuring the angle to which it has been deflected; but in my experiments, to obtain the greatest deflection with a given area of nozzle was my sole aim. To define the exact reaction of a given jet formed no part of these experiments; but when the 'cross piece' was in place, the simple conoidal nozzle, delivering freely into the atmosphere, gave the greatest reaction, and the impelled jet rose to the greatest height.

"The apparatus shown by Fig. 404 has a trumpet-mouthed discharge-tube, the narrow end or throat of which is of exactly the same form and size as the simple nozzle, Fig. 401; and when supplied from the same head of water it will deliver more than double the quantity of water in a given time of that issuing from the simple nozzle; therefore the velocity of the jet at the throat must be also more than double, as the areas of both are exactly equal.

"It may be asked, why such an increase in quantity? In

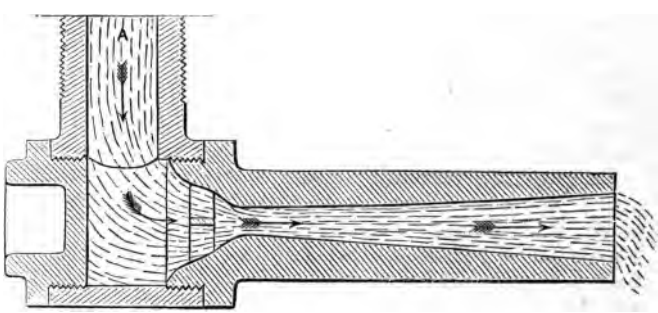


Fig. 404.

answer, I can only say that I account for it through some unknown or not yet satisfactorily explained action of the enlarging jet. This action we can see going on within the tube, and can prevent it by greasing the internal surface when water is the fluid passed through it; but within such a tube there lies a secret, which may be explained hereafter. I had newly finished a gun-metal tube which I considered of a better form than any I had previously tried, and having *polished the inside* of it first with fine emery and oil, and *then with crocus* and oil, it was, therefore, although smooth, *very greasy*, and on experimenting with it I became bewil

dered at the inferior and unsteady results; but on substituting an old tube not greasy, immediately the delivery increased and the results became steady as usual, thus proving the fault to lie in the greased tube.

"I have said that with about 9 ft. head more than *double* the quantity of water would be delivered; but, on lowering the head, thereby reducing the water pressure, a still greater quantity will issue, even as much as three to four times that delivered through Fig. 401, with the same head. Near the throat of the discharge tube there is a constant vacuum, so that the jet of water rushing through the throat attains the velocity due to the head plus the vacuum; whereas with the simple nozzle, Fig. 401, the greatest velocity through it can only be that due to the head alone minus the friction."

In a discussion which followed Mr. Jas. R. Napier observed that he had seen the conoidal nozzle and widening discharge tube very usefully applied in the city of New York. The town lots were, he believed, rated for water according to their area, and the proprietors thereby became entitled to a certain area of pipe from the main. The citizens, in order, apparently, to make the most of this right, have manufactured conoidal nozzles with widening discharge tubes beautifully polished internally. The small end (inserted in the main) has the legal area, while from the other a pipe of three or four times the diameter may lead to the premises.

On page 253 reference is made to water coming through a 1-in. pipe a mile long. I may state that at the residence of Mr. R. B. Robertson-Glasgow, of Montgreenan, Scotland, I took out a ¾-in. lead pipe above a mile long which had been supplying the house with water by gravitation from a well higher than the house for a number of years back. The pipe being eaten and leaking in a number of places, and a larger supply wanted, I got orders to take it out and put in a 2-in. cast-iron pipe instead, and also build a larger additional tank. This was done, and the water has been on since July, 1882.

## CHAPTER XXIX.

### SCIENTIFIC AND SAFE WATER-CLOSETS.

MANY people of late have been troubling their minds very much as to whether or not their water-closets were safe, and it was amusing to hear some of the observations made. One gentleman, *e.g.*, made the remark that he felt bound to believe in the truth of the statement that gases come through water, "for," continued he, "when I sit down upon our W.C., I often feel a cold draught of air coming up, which is anything but agreeable!" Now this "cold draught" here spoken of is a common complaint, but it has nothing to do with gas coming through the water, for if it were gas that caused the draught in the case above referred to, the water in the basin would be bubbling, as if it were boiling. Gene-

Fig. 405.

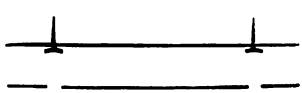


Fig. 406.

rally speaking, the "cold draught" here referred to is a current of fresh air coming up between the flooring and the wall, and which, taking any opening it can get, blows out between the top of the water-closet basin and the bottom of the seat.* This can be easily cured by simply fixing on

* There is room for improvement as to stopping these air passages, as while they can admit cold air sometimes into the closet apartment, they at other times allow stinking air to pass out of it. Even in water-closet enclosures provided with special fresh-air inlet and foul-air *outlet ventilation*, the passage of personal smell when the closet is *in use into other* apartments near—perhaps bedrooms—is often not *properly guarded* against, even although the position marked off for

with ½-in. tacks to that portion of the under side of the wooden seat, all round, right above the rim of the water-closet basin, a piece of ½-in. or ⅝-in. thin india-rubber tube about 4 ft. long, as shown under K K Fig. 407. Small holes are cut out on the under side of the tube (as per Fig. 405, which shows cross-section of it), 2 in. apart, as per Fig. 406, which shows longitudinal section. Of course, the distance between the top of the basin and the under side of the seat must be made to suit the tube, say about, or less, than ⅛ in. all round. In putting on the wood-work, the joiner should see that the top and front of the water-closet seat are so fitted that they can be taken off and put on quite easily, just like a glove. I have of late adopted brass slip-bolts for the front. They are sunk flush.

In regard to putting up a water-closet in the interior of a house from which, so far as it and its pipes are concerned, all danger from sewer or drain gases may be practically debarred, the adjoining sketch, Fig. 407, will easily show. The water-closet in the sketch is supposed to be situated in the upper floor of a two-story house; but, supposing it were a three or a four-story house, the arrangement of the pipes would be the same.

S, Fig. 407, is the surface of the ground outside, B is one of my 4-in., 5-in., or 6-in. vitrified fire-clay ventilating siphon-traps, C is a strong cast-iron plate 8 in. square set into a stone or fire-clay block, or it may be into an iron frame. To one side of the trap, and about two or more feet from it, a fresh-air inlet grating * is shown at A, Fig. 407. By taking off the iron plate at C, the hand or a ladle can be easily got in to clean out the siphon-trap B, should such ever be necessary.

In regard to the drain into which the siphon-trap B is led, it must be seen that due provision is made for its ventilation quite apart from anything in Fig. 407. D is the soil-pipe from the water-closet, the perpendicular portion of which is supposed to be composed of 4-in. cast-iron pipes,

the closet should have caused special precautions to be taken when the house was being built. Up to this date we are a somewhat uncivilised *nation as to this*; advance is being made, however, especially since the *practice of* exposing the closets was introduced.

* *The grating* may be larger and have more holes in it according to *taste.* I use the gratings 8, 10, 12, and 18 inches square, with 36, 64, *100, and* 196 holes, as best suits the case. Also see Fig. 460.

with a 4-in. iron elbow at the junction with the fire-clay siphon-trap. Some architects and plumbers now use pipes 3½-in., or even 3-in., diameter internally for soil-pipes, and especially for only one water-closet. G is the 4-in. cast-iron or lead ventilating-pipe. Upon its top a self-acting Induced-Current Fixed Ventilator may be placed if wished; the fresh air entering at A rises up through D, and G, and goes out at H, carrying with it whatever gaseous exhalations may arise from off the interior of the pipe, thereby lessening any danger from the soil-pipe by preventing the *accumulation* of any bad gas or foul air within it. J is the safe pipe carried out through the wall with a light hinged valve on its outer end.

Underneath the seat K K, the two small circles show the position of the india-rubber tube put in to stop the cold air draught as above referred to.

L is an earthenware *wash-down* water-closet, M is a 2-in. air-pipe to ventilate the branch soil-pipe and prevent siphonage of closet trap.

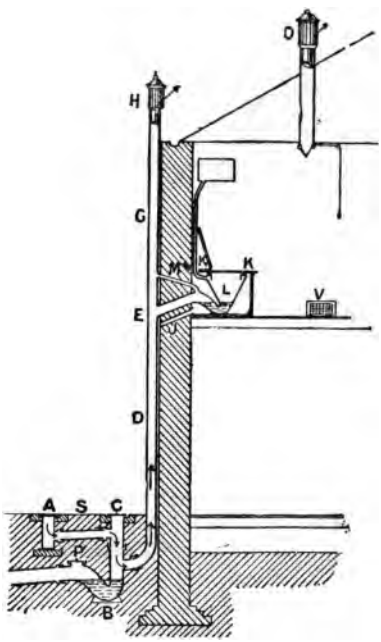


Fig 407.

O, Fig. 407, is a ventilator for the space or enclosure in which the water-closet is situated; a simple hinged valve is attached to the bottom, by which it may be opened and shut as desired. When opened, an upward current is assisted by my Induced-Current Fixed Ventilator upon the top. V indicates a fresh-air inlet grating. Dr. J. B. Russell, Medical Officer of the Sanitary Department, Glasgow, and Mr. Kenneth Macleod, Sanitary Inspector, expressed their warm approval of the style of trapping and ventil

tion shown by Fig. 407, considering it a decided advance as regards safety upon any system of water-closet fitting previously brought before the public.*

Fig. 408 shows a Bramah valve water-closet fitted with two ¾-in. or 1-in. ventilating-pipes A and B for ventilating the space between the bottom of the valve and the top of the water in the lead siphon-trap. These two pipes must always be led out to the fresh air *per se*, and must not be joined to any other pipe.

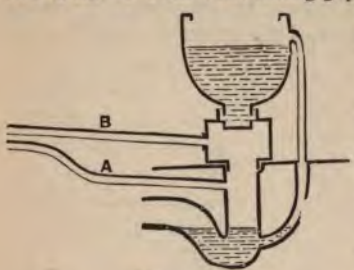


Fig. 408.

Fig. 409 shows another style of joining the air-pipe to the disconnecting trap, which has been adopted sometimes for soil-pipes coming down in the interior of the house, the "air-pipe" being led out through the outer wall of the building to the fresh air. This "air-pipe" is the inlet, the soil-pipe being the outlet ventilator.

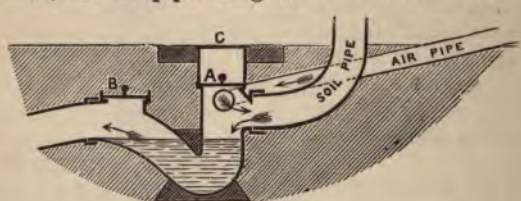


Fig. 409.

In connection with Fig. 407, it has been shown that, by the insertion of the ventilating siphon-trap B, all aërial communication with the water-closet soil-pipe and the drain has been cut off, thus protecting the water-closet from both the drain and the sewer. How much more, therefore, would fixed wash-hand basins in dressing-rooms and bedrooms be made practically safe if they were properly fitted up upon the same principle? viz., a 2-in. deep-locked lead siphon-

* This was in about 1878, and thousands of closets have been so fitted since, to the enhanced safety of the community. In Fig. 407 the closet is shown encased with wood, but it may be exposed, having only the seat on the top—as shown in Fig. 210 and 234.

trap at the basin, with a 2-in. or 2½-in. waste-pipe leading down therefrom and *discharging above the surface of the water in a ventilated siphon-trap;* the waste pipe being ventilated at its top out to the outer air.*

Fig. 410 will help to give an idea of a wash-hand basin situated on the upper floor of a two-story house, and the waste-pipe leading down into a ventilating siphon-trap under the ground. In this case the waste-pipe does not generally require to have a ventilating-pipe carried up to the roof, as did the soil-pipe in Fig. 407, but instead, the top of the waste-pipe may have a number of ⅝-in. holes bored near its top for ventilation, as shown at B, Fig. 410.

Fig. 410.

An air-pipe as at P, Fig. 303, is put in and led out through the wall. The size of ventilating drain-trap at Fig. 410 is 4 in. For full particulars as to the basin fittings themselves, see Chapters XIX. and XX.

Several years ago various persons asserted that by putting on a ventilating-trap at the bottom, and a certain rotating ventilating cowl upon the top, of a main soil-pipe having water-closets, baths, basins, and sink *all branched into it*, that thereby the use of a lead siphon-trap might be dispensed with, not only for the closets, but also for baths, basins, and sink! I consider such an idea a highly dangerous mistake, for the cowl would be of little use when there was no wind, especially if the action of the fires in the house could have any effect upon the soil-pipe, or, as I have seen, it might be stuck fast and its tail to the wind. Then every time a closet was used a stinking puff-out would take place at each basin, bath, or sink. This is the reason, I suppose, why siphon-traps have been put on for the bath and sink at Guy's Hospital,†

* The open air-channel style, shown in Fig. 429, may be used, especially if the open channel is away from the windows.

† *See Plate VII.* in Mr. E. G. Banner's pamphlet on "Wholesome *Houses,*" published by Messrs. Crosby Lockwood and Co., or Fig. 17 *in a newer edition*, which proves that the remarks of mine referred to

notwithstanding the trap and cowl above referred to were upon the soil-pipe. Without the siphon-traps the soil-pipe would be apt to act as a disagreeable speaking tube, as well as a stinking inlet ventilating-pipe.

Above thirty years ago I saw sinks that had been fitted up without siphon-traps, had afterwards to get them put in, even although the waste-pipe discharged above the ground. It was found that dirty water put down one sink caused a rush of stinking air to come out at the other sinks. The putting on of the siphon-traps stopped this and tended to isolate each sink or house by itself, and so not only remedied a nuisance but also acted as a barrier to disease germs entering the house through the waste-pipe.

Before closing this chapter upon scientific and safe water-closets, I show, Fig. 411, diagram of a "Carmichael" wash-down closet fitted up and its soil-pipe trapped and ventilated as executed at various places, especially for houses and schools. B is a Buchan disconnecting trap, as per Fig. 415. In this case, instead of the fresh air coming in through a perforated iron grating right over the trap, said fresh air comes down inside the rain-water pipe, through the trap, and up the soil-pipe and out at the Induced-Current Fixed Ventilator C, which causes the current of air to move through the pipes. This plan is very useful where the trap is quite close to a door, or where the open grating, as at a school, would be a temptation to the boys to be peering down through the holes, or dropping small stones or sticks into the trap through the apertures *to see the effect*. Fig. 460 style of fitting in the trap is sometimes used to guard against this latter trick.

at page 49 of said pamphlet, and at page 105 of newer edition, published elsewhere, were right after all. At page 487 of *Building News* for October 22nd, 1880, the architect, Mr. Arthur Billing, admits the waste-pipes were *bent*, so as to serve the purpose of a siphon trap. See page 63 of the *Plumber and Decorator* for April, 1881. Further, at pp. 376, 377, of the *Sanitary Record* for June 15th, 1877, Mr. Ernest Turner, F.R.I.B.A., gives an account of certain experiments made by him and also by me, in which the danger in practice of the above idea was clearly demonstrated; while Mr. John P. Seddon, F.R.I.B.A., on pp. 831—832 of the *Building News* for June 30th, 1882, stated that *the attempt to* do without the lead trap on the waste-pipe of his own *bath had ended in* failure, owing to the bad smell that came up the *pipe. This smell* was caused by the current of air through the pipe *first drying its* interior and then dislodging particles of soap and *matter washed off* from the skin, &c., which small particles, in thousands, were delivered into the atmosphere of the bath-room.

Fig. 460 belongs to the low level inlet and high level

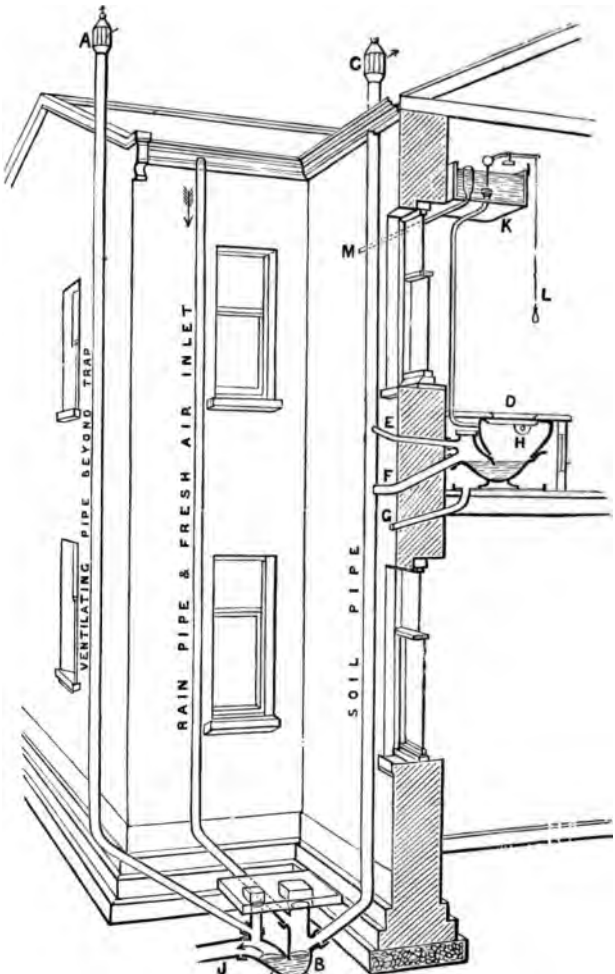



Fig. 411.

*outlet style* of ventilation, while Fig. 411, which I am he *describing*, shows both inlet and outlet at a high level.

closet H, here shown, has no working parts about it to get out of order, while *the water in the trap* is above the floor and *in sight*. So there are no out-of-view dirt-collecting corners about it to stink. The water-flush is effected and the closet cleaned out by simply pulling down the handle or cord L, the water being supplied from the cistern K. Of course several closets may branch into this same soil-pipe, although I only show one here to illustrate the principle.

Where it is wished to ventilate the drain J beyond the trap, a special up-cast ventilating pipe may be put up and surmounted with one of my Induced-Current Fixed Ventilators, as shown, as at A, Fig. 411, or as per D, Fig. 461.

I may here again condemn the dangerous unhygienic pseudo-water-saving policy of restricting the water-flush of a closet to only two gallons. Four gallons a flush would be more sensible. I am glad to find a number of practical sanitarians join in disapproving of this foolish curtailment of the water-supply for closets. There is a happy mean in everything, but the two-gallon flush is a long way below it, and the sooner the law is altered, wherever it is in force, upon this point so much the better for the proper working of closet and drains. In connection with this many *civil* engineers are very poor *sanitary* engineers.

In 1893 the Sanitary Institute carried out a series of experiments to see the effect of flushing closets with only two gallons, and as the result condemned the practice as inefficient, recommending the flush to be at least three gallons, or between three and three and a half gallons.

## CHAPTER XXX.

### Disinfectants for Water-closets, Bedding and Clothing.

The simplest disinfectant for general use is the atmosphere. Proper ventilation should therefore be seen to in connection with all water-closets and their sites. What I have termed the *oxygenous disinfectant* (which is supplied gratis by its universal dispenser Mr. Atmosphere upon proper application), has been already referred to in explaining the effect of ventilating the trap and soil-pipe, the result of the circulation of the air through the interior of the soil-pipe constituting said pretty good, although so cheap, *oxygenous disinfectant.* When sickness is in a house, it is often desirable to supplement the action of the atmosphere, hence certain manufactured disinfectants, like medicines, require to be used. One that has been highly recommended is *chloralum.* It may be applied automatically by means of apparatus fitted in or near the water-closet for that purpose.

Mr. Jennings, of London, supplies an "Automatic Disinfector" for 42s., which, after it is fitted up, discharges so much chloralum into the basin each time the water-closet handle is pulled. There are others in the market, including a new one by Dr. McCallum, of Pitlochry, Perthshire, costing about 30s. He advocates the use of corrosive sublimate or bichloride of mercury, 25 grains being discharged into the 3 gallons of water in the cistern, equal to 1 in 8400. In using this poisonous disinfectant the doctor puts himself in opposition to Mr. Eassie, only we must distinguish between real and sham, as well as partial and total, disinfection,* also that disinfection and deodorisation are

* *E.g.* the outside of solid fæces might be disinfected while the inside was not.

not equivalents. The worst of these disinfectors is, that unless the supply of the disinfectant is kept up, which costs both money and time, the apparatus is then useless, people getting tired of the trouble, unless during the prevalence of fever either in or near the house. Another objection in some cases is the discolouration of the water. The red tinge given to it in the basin being somewhat too suggestive of blood. Instead of using these "Automatic Disinfectors," many persons content themselves with putting the disinfectant into the chamber-pot or down the closet by hand. The following extract from "Healthy Houses," by the late Mr. Wm. Eassie, C.E.,* will be found most useful and interesting:—"The disinfectant used in a household ought certainly to be a non-poisonous one. Fortunately, or unfortunately, there is not any choice, for the only one of this description is chloralum, now adopted by the Board of Trade. This is the popular name bestowed upon it by its inventor, Professor Gamgee. It contains 1,500 grains of hydrated chloride of aluminium to the pint, or about 75 grains to the ounce, and is sold in a fluid and solid state. Slightly diluted, the former will disinfect secretions in the utensils of a sick-room; and exposed in a saucer in its concentrated form, I have found it to remove even the smell which is given off by a newly painted room. In its powdered state it may be sprinkled in cellars, larders, dustbins, ash-pits, stables, piggeries, poultry houses, and wherever a smell is continually arising. In the deodorization of sewage, whilst being pumped over the garden, one gallon of the fluid, or three pounds of the powder, will suffice for 150 gallons of sewage." †

As regards the disinfection of clothing in the laundry, Mrs. Meredith, the patroness of the Discharged Female Prisoners' Aid Society, lately wrote to the *Standard* newspaper as under:—

"The articles taken in for the wash are fairly sprinkled with chloralum powder; they are then packed in sacks, in which they remain for about two hours, when they arrive

* Some years ago Mr. Eassie was engaged upon a new Dictionary *of Sanitary appliances*, which seemed likely to be a valuable contribution *to sanitary literature*. The articles appeared in the *Sanitary Record, published at* 15, Waterloo Place, London.

† *For deodorising* cesspools and sewage, Condy's fluid, alias *permanganate of potash*, has a good effect.

at the washhouse. They are then unpacked, and shaken singly. After this they are put in a large tank, where a great quantity of water flows over and through them. In this way they rest for at least twelve hours. They are then wrung out, and undergo the ordinary process of washing. It is highly satisfactory to add that not the least deterioration of texture or colour results."

According to Dr. John Dougall, Glasgow, who has studied this subject closely, the best aërial disinfectant is the fumes of burning sulphur.* The use of carbolic acid is, however, condemned as illusory. As to sulphur, we find Homer, in the Odyssey, bk. xxii., saying of Ulysses, that—

> "With fire and sulphur, cure of noxious fumes,
> He purged the walls and blood-polluted rooms."

In regard to the disinfection of wearing apparel, bedclothes, &c., on a large scale in a city or town, Mr. Peter Fyfe, Sanitary Inspector for Glasgow, in a paper read before the Philosophical Society of Glasgow, in April, 1888, explained an improved method which he had introduced at the Belvidere Sanitary Washhouse for the purpose of destroying infected matter before the employees begin washing operations upon them. It consists in the use of a solution of bichloride of mercury in water of 1 in 5,000, with which the articles are thoroughly saturated for half an hour. In order to impregnate the clothing *at once* with the liquid, an hydraulic press and suitable bogies are employed.

Mr. Fyfe also referred to the use of steam disinfectors, in which beds, bolsters, pillows, and all unwashable articles except carpets, are placed and subjected to the influence of steam at 7 lbs. pressure—giving a temperature of 234° F.—for an hour. The effect of steam at this pressure is shown to be better and quicker than that of hot air of much higher temperature. Dr. Koch proved that while four hours' exposure in hot air at 284° F. did not kill the spores of baccilli in the centre of a roll of flannel, the temperature having only risen there to 181° F., exposure for one and a half hours to steam at 248° F. raised the internal temperature to 242° F. and killed the spores. Steam, there-

* *The disinfectant* he uses for typhoid excreta is hydrochloric acid or "*spirits of salt*," diluted in twenty times its bulk of water.

fore, penetrates porous objects more rapidly and deeply than hot air.

Such being the proved value of disinfection by steam, one would have thought that provision for its appliance would be handily provided all over the country; but such is not the case. In a township of about twelve thousand inhabitants, not above five miles from the centre of a city with above half a million inhabitants, the sanitary authority, as I write, "have no facilities for disinfecting the blankets and bedding beyond hanging them up in the room when it is being fumigated." There is surely room for improvement here.

Another factor in preventing the spread of disease is sufficient hospital accommodation, and especially for infectious diseases. This as yet has been far too little attended to. In a really civilised country the hospital should be a landmark equally with the church or the jail. In fact, the want of proper hospitals tends to fill our jails. In this relation people have for far too long given way to sentiment and neglected the duty that lay to their hands. Distance has lent its usual enchantment to the view, and so the money that ought to have really benefited our brethren in this world has been sent abroad to provide mansions in the skies for foreigners. The foreigners have not taken altogether kindly to this poetry, however, and now we have come to prose in the shape of medical missions with useful hospitals, which are proving of great service to the communities in their neighbourhood. One such has been recently established on the classic shore of the Sea of Tiberias, and done so much good to the natives that they have been led to look upon the physicians as demi-gods. What reduces human suffering and promotes health tends to make a heaven of earth.

## CHAPTER XXXI.

### Improved System of House Drainage.

Until the eighth decade of the nineteenth century A.D. the style of the fire-clay siphon-trap that was generally put upon house-drains is that shown in Fig 412,* but, as will be seen, while this provides for the locking off of the gas from the common sewer, no provision is made by it for the ventilation of the house-drain.† A slight but highly-important alteration, however, made in its shape, as per Fig. 413 (which shows perpendicular section, just as does Fig. 412), not only shuts off the gas from the common sewer, but also allows the drain leading down from the house to be ventilated.

One great objection, however, I made to the style of trap

Fig. 412.

Fig. 413.

in Fig. 413 was that the surface of water exposed at X is far too great, while no provision is made to prevent the lodgment and accumulation of floating fæces, &c., at X. Another objection against Fig. 413 is that the water cannot be seen coming into the trap. On these points Fig. 413 is no worse than many other traps; that was no reason, however,

* It is styled the "Cesspool Trap," or the "Sow-back Trap."

† Neither is any provision made for cleansing the house side of the trap, as the cleansing eye, A, only provides for clearing out the fæces and sediment which accumulate in the middle of the trap. In fact this Fig. 412 style of trap is a very dirty and unsanitary appliance.

why these faults should continue to exist. Upon thinking over the matter, therefore, a new form of siphon-trap came into my mind, and as it not only removed all the above

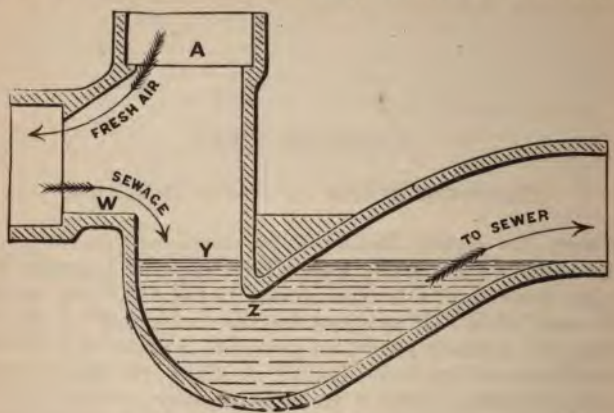



Fig. 414. No. 1 Trap.

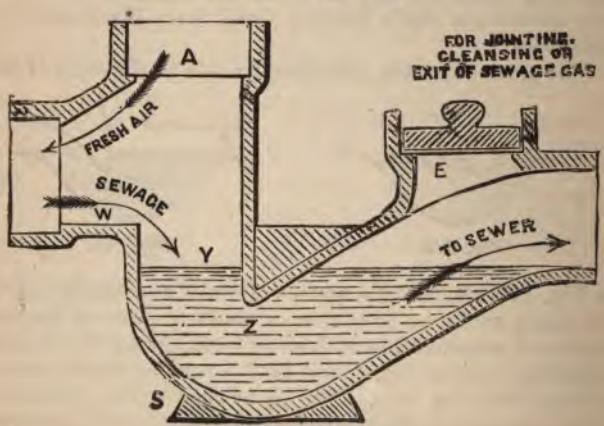



Fig. 415. No. 2 Trap.

*objections*, but was also quite simple, and capable of being *easily* adapted to existing drains, and to many various *purposes* in connection with house-drainage in general, I, in *April, 1875*, applied for Letters Patent for it, and made

arrangements with Messrs. J. & M. Craig, Kilmarnock, Scotland, for its manufacture,* and its wide and increasing popularity shows that it supplied a public want; it combined simplicity and cheapness with thorough efficiency and ready adaptability in a manner that is not found in any other trap.† This is partly due to the "cascade-action," as Professor James Thomson, of the University of Glasgow, termed it, of the water when flowing into the well Y of the trap, and to its simple siphon form.

Figs. 414 and 415 show vertical sections of Nos. 1 and 2 forms of this improved disconnecting ventilating siphon-trap. No. 2 is shown with seat or sole S.‡

In the 6-in. size, the surface of water exposed at Y, Fig. 415, is under one-fifth of a square foot. Owing to this and the drop of 2 in. or so which the water gets in falling from the drain branch W, into the well of the trap at Y, the objections made above against Fig. 413 are removed in Fig. 415, and instead of the flow-down of the water merely running away underneath the floating fæces as at X, Fig. 413, the fall of the water at Y, Fig. 415, breaks up and carries away the fæces, &c., thus leaving comparatively pure water always at Y, Fig. 415, in place of the usual accumulations of filth. In setting these traps the best plan is to fill them with water, which shows the exact amount of both the drop and water-lock. *The No. 2 form is the better one to use.*

* They have agents and depôts in many cities and towns. Messrs. Walter Macfarlane & Co., Saracen Foundry, Glasgow, supply the traps in iron.

† Both Mr. Baldwin Latham, C.E., and Mr. John Honeyman, F.R.I.B.A., approved of the vertical drop; the latter wrote me that he considered it a distinct improvement upon his own "Somerset" trap, and that he would use my trap in preference. Drain-traps with round edges are not so self-cleansing as this with the sharp edge at W. I always use the No. 2 style, as with it the workman need not leave cement sticking up at the outer joint as with No. 1. Partly for this reason Messrs Craig have reduced the price of No. 2 trap to the same as No. 1, so as to give no excuse for using No. 1. Yet such is the perversity of human nature that many masons, &c., prefer to use the inferior No. 1 trap. See Fig. 416.

‡ At the Philosophical Society's Exhibition, Glasgow, 1880, the only first-class award with medal granted in the Sanitary Section to any exhibit in fire-clay was awarded to this trap; while at the International Medical and Sanitary Exhibition, London, 1881, it received two first-class awards; and at the London "Healtheries," in 1884, it got the gold medal; at Edinburgh, in 1886, it got the silver medal; at *Glasgow, in 1883*, the author's exhibits received the medal of the *Sanitary Institute.*

The amount of water-lock or dip of the tongue Z, Fig. 415, into the water may be about or fully 2 in. : more is unnecessary and does more harm than good, especially where water is running through the drain every day. Dr. Fergus agreed with me upon this point. In the case of the lead siphon-traps, especially for basins and baths *inside* the house, I recommended a greater water-lock, but the circumstances are quite different.

At page 70 of "Reports of the Medical Officer of the Privy Council and Local Government Board," New Series, No. VII. A.D. 1876, Dr. George Buchanan, in his report upon the outbreak of enteric fever at Croydon, recommends the use of a trap upon a similar principle to mine to be placed between the house and the sewer; while Mr. Baldwin Latham, at page 408 of the 1878 edition of his elaborate work on "Sanitary Engineering," after describing the recent Model By-Laws issued by the Local Government Board in reference to House Drainage, says :—"This is, in fact, the system patented in April, 1875, by Mr. W. P. Buchan," &c.

The portion of my patent which agrees with the Model By-Laws is Fig. 5B, but Fig. 5A (see Fig. 407) of said patent, where it can be applied, and I have often done it in conjunction with Fig. 5B, is better.

Fig. 417, with the soil-pipe going up outside of the wall, shows the plan ordered in the Model By-Laws, while Fig. 407 agrees with clause 15, page 9, of the "Suggestions" as to drainage, &c., drawn up by Mr. Rawlinson, C.B., C.E., for the Local Government Board, and published at the end of 1878. See also Fig. 461.

Shortly after the introduction of my No. 1 trap, shown in Fig. 414, I found it necessary to improve upon it by the addition of another opening, this time on the top of the *outer* end of the trap, as shown in Fig. 415, which illustrates my No. 2 style of trap.

One reason for the addition of this extra opening, shown at E, Fig. 415, was that I found the masons or other tradesmen in fitting in the (No. 1) trap, were liable to leave the cement sticking up inside of the pipe, at the joint as shown at B, Fig. 416, and as a consequence the trap and the drain *behind it soon got* choked up as shown at C and D, Fig. 416, *to the discredit of* the work. To remove the cement sticking up at B, a hole had to be cut in the top of the trap at H, but, as prevention is better than cure, it is obvious that it

would have been better to have had a proper opening at H at first. It was, however, with this as with many other things, *experientia docet.*

In Fig. 415 the outer opening E is closed with a lid, but when the opening at E is used as a ventilator for the drain or sewer beyond the trap, then a pipe is carried up from E, Fig. 415, as shown at E, Fig. 417, where the lid is shown higher up. This lid can be sealed down with lime, to prevent escape of sewer or drain air past it, but in such a way as not to prevent the easy removal of the lid when desired. I use strong cast-iron lids in my own work.

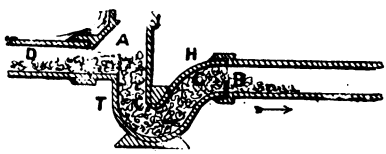


Fig. 416.

By the insertion, therefore, of such a simple yet efficient style of ventilating trap as Fig. 415, which is the better one (Fig. 417 shows one mode of application), the foul gas from the sewer is not only kept back as formerly, but also, *in addition*, the inner side of the siphon-trap at W, in conjunction with the opening at A, serves as a ventilator for the house-drain, preventing that accumulation and concentration of drain-gas, the horrid smell from which I have so often felt proceeding from an opening newly made into that portion of the house-drain just behind the old form of siphon-trap. It follows, therefore, that supposing the drain inside of the house to be leaking, the fresh air coming in through A, Fig. 417 (or it may enter as per A, Fig. 407), dilutes any bad gas in the drain greatly, and makes it less dangerous. Greater safety to the inmates is, however, derived from the use of the Sectional System of drainage, where a special shaft is put up to ventilate the drain, and the soil-pipe trapped off from the drain at the bottom and ventilated *per se.*

See examples of this Sectional System of drainage in Figs. 407, 410, 411, 422, 425, 430, 461, 462, 463, and 471.

With iron gratings in the *middle* of the street above the sewer, as shown at L, Fig. 417, the fresh air can enter down through these gratings and the diluted foul air come out *above the roof* at C, Fig. 417, where the wind would carry it away. I designate this the high-level system of outlets for *sewer air in* contradistinction to the low-level system, which, *by using* the gratings in the streets both as inlets and out-

lets, allows the sewer air to blow off under our noses, and,

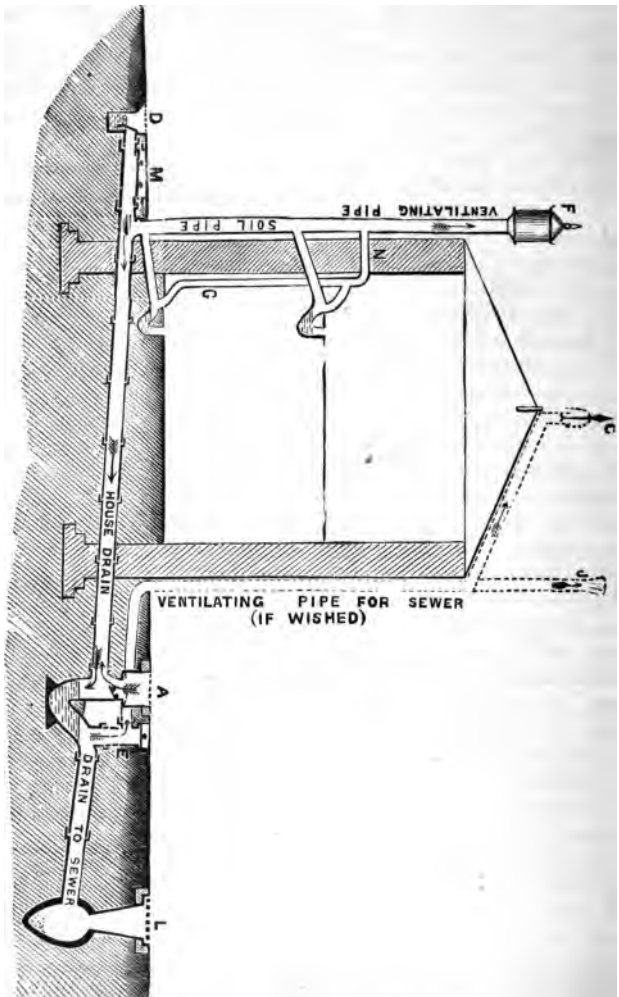



Fig. 417.

*what is worse*, our mouths, in place of high above our heads

Gratings for sewers should be in the middle of the street, and at the centre of crossings, never in the line of or close to the footpath or pavement, as often very badly put in.*

In cases where there is danger of a pressure of sewer-gas forcing itself past the dip or tongue of the siphon-trap, this is guarded against or prevented by the putting up of the sewer ventilating-pipe, shown in Fig. 417.

The proper position of the siphon-trap A, Fig. 417, where there is sufficient open space, would be from 8 ft. to 12 ft. out—as found most suitable—from the house (in various cases the grating is only 1 ft. from the house, yet the traps work satisfactorily, especially when not right opposite and close to a door).† The *fresh air* entering down through the perforated gratings at A, proceeds along the drains, carrying any foul air in the drain along with it, up through the soil-pipe and out above the roof at F.

When the soil-pipe goes up outside of the wall, it is of considerable advantage to the ventilation and the insuring of a constant current of air up through the pipe, to place one of my 4-in. Induced-Current Fixed Ventilators upon the top of the soil-pipe. I tried the Archimedian screw ventilators ‡ for this purpose, but have given them up, as I find the fixed ventilators act much better, and are not liable to get out of order, as they have no moving parts.

I have found the foregoing 4-in. fixed ventilators (9 in. dia. in body) draw up at the rate of about one thousand lineal feet per minute during a high wind, while even when there was little wind I have found a good current of air

* Disinfecting the sewage air by means of gas burning in the outlet shaft may sometimes be useful in ventilating sewers and hospital drains, but burning gas means considerable expense if to be of any real benefit, and requires attention.

† In cases where the ventilating-trap had to be put in quite close to and in front of the door, I have put an iron close lid immediately above the trap, and put in a branch at the side with pipe led to a convenient distance back, from the door where the fresh air entrance grating was placed, see Fig. 460. Sometimes a rain pipe, as at Fig. 411, may act as the fresh-air inlet.

‡ I do not consider the Archimedian screw ventilator a proper appliance for soil-pipes at all, as when it is moving the screw blades prevent the quick admission of air to the soil-pipe when a closet is discharged, and when not moving, in calm weather, the screw blades *choke up the pipe*. Some again make a very disagreeable noise when *revolving*.

immediately set in through the drain or pipe when the ventilator was put on, where without it there was no movement of air through the pipe.

For greater safety so far as the health of the inmates is concerned, the sewer ventilating-pipe when put in should always go up the *outside* of the house. It should be of iron, so that rats could not eat it, and their passage up it from the sewer must be guarded against.

In gentlemen's houses which have a sunk area at the front of the house, said area is often a good site for a ventilating fire-clay siphon-trap. I have, however, fitted them in all sorts of positions with the most satisfactory results.

In places where they have supplanted the old built cesspools the improvement has been most marked. Some of the first alterations in this way were done at the instance of the late Dr. And. Fergus of Glasgow, *e.g.*, at one place where there was a large built cesspool at the place before, the smell that arose and lasted for a long time after the cover was removed was very bad. A portion of this smell got into the house through the rat-holes. The cesspool being deodorised with Condy's fluid, was emptied and disinfected and afterwards filled up, while the rat-holes were built up with Roman cement and broken bottles.

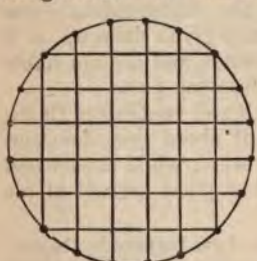


Fig. 418.

Why so many of these sewage gas retorts have been set down within a few feet of the front of many of our best West-end houses I cannot understand, as with the help of the rats they are bound to manufacture head-aches, fevers, &c., for the inmates, more or less, according as the circumstances happen to be favourable. If there were large gardens attached to the houses, and these sewage tanks put in at the bottom of the gardens, to save and utilise sewage, then one might see some object to be gained, but there is nothing of that in the cases referred to.

I have said that at A, Fig. 417, there are two gratings, *the under one*—which may be made of iron, or brass wire *tinned*—*is put* in to prevent stones or rats getting into the *drain if the* topmost grating were off. Another use of the *under grating*, Fig. 418, is to serve as a support for char-

coal, should it be wished to turn the ventilating-trap into a deodorising ventilating-trap. I prefer, however, to dispense with the charcoal in this case, as it stops the draught, and I have considerable faith in the virtues of a good draught of fresh air *when judiciously applied.*

In regard to the question :—And what about the frost? It may be stated that it is now nearing twenty years since these ventilating disconnecting-traps were introduced, and as more than a hundred and thirty thousand of them have been fitted in, and I do not remember of even one case of freezing, the cases of freezing—if any—must have been few. The reason of this freedom from freezing is, that the traps are put in below the ground, and generally two feet or much more from the surface of the ground to the surface of the water in the trap. Then the fact of the surface of the water in the trap being below the level of the bottom of the drain coming into it, is also a safeguard, as is also the rounded corner at the *top* of the trap, round which the entering air glides easily into the drain, and so keeping away from the water in the trap.

When the house the trap—especially the main disconnecting-trap—is fitted in for is occupied, warm water is often put down the drain and so the trap is heated, and when it is heated it heats the ground around it, and so cold sufficient to freeze the water is prevented.

As to those eighth-decade theorists who prophesied that the trap would not work, they have been mistaken. They

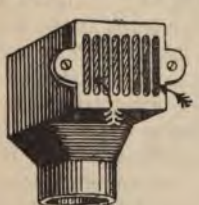


Fig. 419.

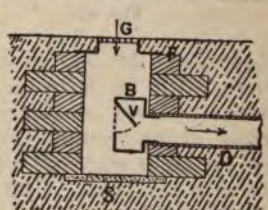



Fig. 420.

said bad smells would come out of the grating to the annoyance of those near by, but complaints on this score have been easily prevented by the use of side fresh-air inlets, as also by the use of air inlet-valves like Fig. 419, or as shown in Fig. 420, which allows the fresh air to get in but prevents

air coming out. The proper outlet for the foul air being above the roof.

In my own business I do not think I have put in as many on an average as one every two years of these self-closing inlet-valves for drains, although I have made often and general use of the *side fresh-air inlet*, not only as a preventive against a momentary puff out of bad air, but also to prevent children choking the trap by putting sticks or wires down the grating. See Figs. 460 and 470.

For a disconnecting-trap set as per A, Fig. 417, I prefer that an iron plate be put in over the trap at A, and the iron grating for the fresh-air inlet to be at the side, as shown at A, Fig. 407, so that children cannot choke the trap with sticks or wires. The iron gratings and plates used in this connection should be strong and heavy; the small ones at least about ⅝ in. thick, and the large ones thicker still.

The good tradesman who desires to give entire satisfaction attends to such details as these, the ignorant one does not, while the scamper does as little as he can. There is hardly anything where highly educated experience or inspection is more necessary than in connection with the drainage of buildings.

Fig. 421 shows perpendicular section of a 10-in. square ventilating iron grating B, set into a slab of freestone about 16 in. square.* This grating has 64 ½-in. holes in it. For traps at the foot of soil-pipes and for 6-in. drains, I often use grating only 8 in. square, with 36 holes in each. It is a mistake in my opinion to have too large drain-inlet air-gratings at the surface of the ground. For larger drains than 6 in. I use 12-in. gratings with 100 holes, and sometimes strong 18-in. ones with 196 holes. The latter may be over man-holes.

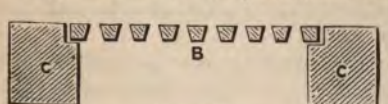


Fig. 421.

In Fig. 417, D is the surface grating for the water off the back court. A small *trapped* fire-clay or cast-iron sand-box is shown below it, to prevent the sand getting into the drain. No air is to be allowed to enter at D. In Fig. 417,

* *The masons* charged so high for these that I got patent fire-clay *blocks made at* half the cost, of which a great many are used. Lately, *now, for grass*, earth, cement or asphalte, and for neatness, I mostly *use my cast-iron* frames for the gratings or plates. See page 300.

which gives perpendicular section, the house drain is shown

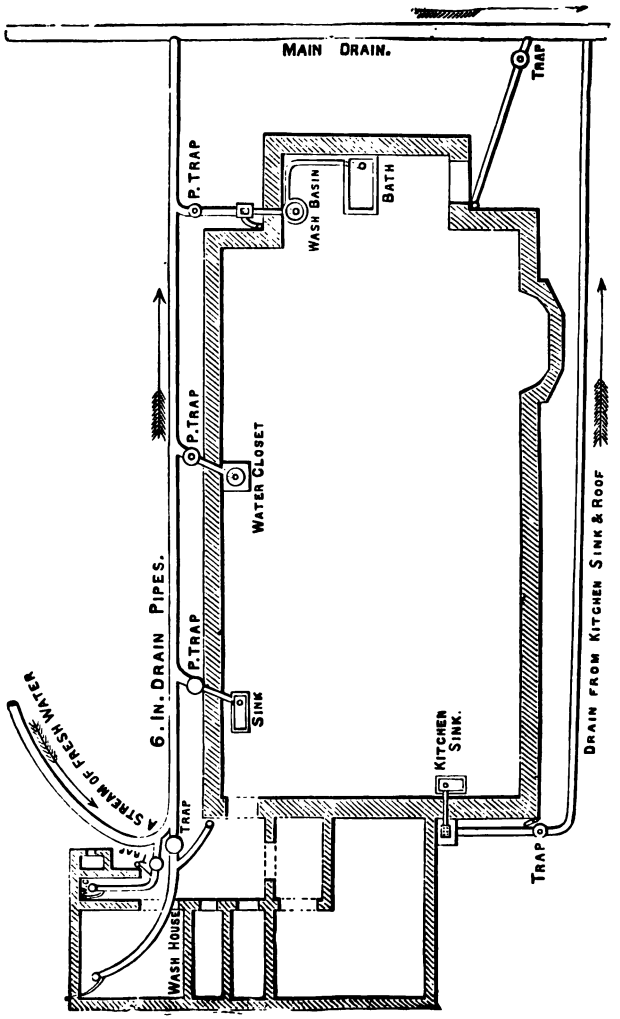



Fig. 422.

*as running* right through the house; this is a very common

style in buildings erected in cities, where the houses or buildings are packed close together, with only the gables intervening. It is not a plan to be recommended however.* If the sewer were in the lane at the back of the houses it would be better, as then, all the sanitary fittings being at the back of the house, no drain with foul gas in it need go through the house, but only a drain-pipe or conductor for

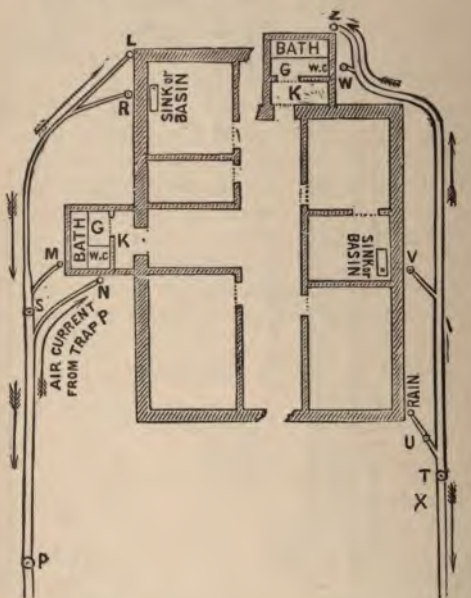



Fig. 423.—Ground Plan.

Fig. 424.—Ground Plan.

the rain-water, which could easily be locked off from the soil-pipe drains by means of a ventilating trap. In country or suburban residences, however, where the houses are more isolated, the drain in many cases does not require to be led into the interior of the house.

* *When drain pipes of fire-clay or stoneware run through the interior of a house they should be laid on concrete, and, after being smoke-tested, concreted all round. Or else, as now often done, use strong iron pipes for the drain, with spigot and faucet joints run with lead, and with proper access-openings and lids on the top of the pipes.*

The annexed rough sketch (Fig. 422) of the ground-plan of Shaftesbury Lodge, Wemyss Bay, on the banks of the Firth of Clyde, will give an idea of how the house was locked off, or disconnected, so far as the passage back of sewage gas into it was concerned, not only from the main drain or sewer, but also from its own private drains. I had nothing to do with the original work, being called in (in February, 1876) owing to bad smells being complained of. The large main drain is an old square-built drain running through the grounds: the branches off are fire-clay pipes. The idea of leading in the fresh water is the gentleman's own, a long distance being laid with 6-in. fire-clay pipes to bring the water from the higher grounds.

I may now proceed to explain what I have termed the Sectional or Detached System of House Drainage,* to which reference was made some pages back. Figs. 423, 424, and 425 show plans of locking off, not only the sewer gas, but also the drain and soil-pipe gas, and other water-closet smells from the house. In this case *extra* precaution exists by having the water-closets erected in a special wing, say at the back of the house, and in the spaces marked G G. A covered or enclosed passage, with a door and window (or windows—one on each side), intervenes between the body of the house and the water-closets, as shown at K K.

While due provision is made for *necessary* ventilation of the passage or lobby K K, the inmates must, at the same time, be protected from cold, hence I object to the lobby K K being quite open or exposed to the weather. The joists of this lobby ought to be laid across it, and not with their ends to the wall of the main building, in order to prevent gases or impure air passing between the joists to main building. In cases where this extra precaution cannot be had owing to the house being already built, some such *arrangement of the pipes as shown above ought at all events to be adopted.*

A, Fig. 425—or W, Fig. 424—is the 4, 5, or 6-in. Fire-Clay Disconnecting Siphon Trap, which locks off the drain and sewer gas, and at the same time allows a continuous current of fresh air to blow through the soil-pipe. It has also a peculiar drop, giving the cascade-like action specially

* *This system is further illustrated in Figs. 462, 463, 464, and 471. The latter, Fig. 471, shows the use of the inspection or access-pipes at the branches.*

recommended by Dr. George Buchanan of the Local Government Board.

B, Fig. 425, is a No. 1 fixed exhaust ventilator (in a style shown at Fig. 489), on top of the soil-pipe. C is also an induced-current fixed ventilator, with 4-in. pipe for ventilating the enclosure in which the water-closet is situated.

The erection of this has given great satisfaction where

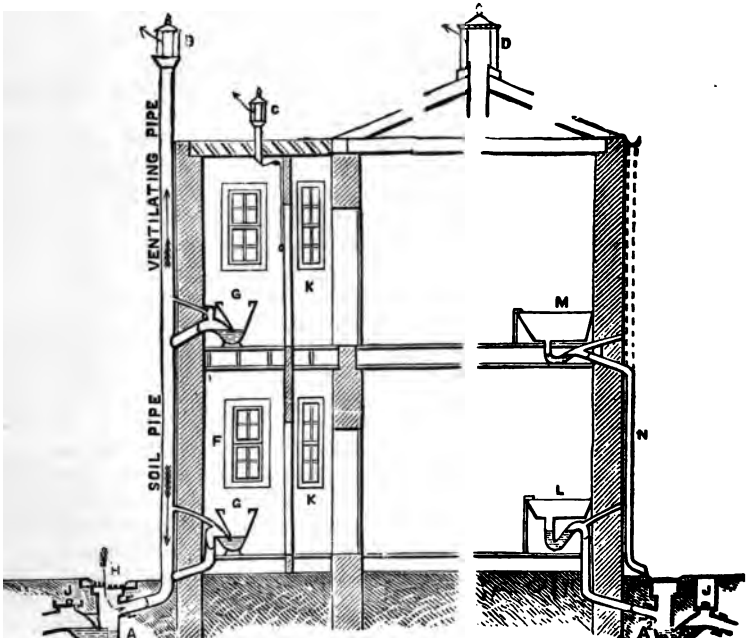



Fig. 425.—Elevation.

done, and where considered necessary a fresh-air inlet may be made in the floor, or where most suitable. D, 425, shows position of one of my No. 2 Fixed Exhaust Ventilators upon *the ridge* of the house.* It may ventilate the staircase. *G G show* different styles of the "Carmichael" Wash-down

* See text-book on "Ventilation," No. 271 of Weale's Series, as to these.

Closets, erected in special apartments projecting beyond the house, and with an intervening lobby. The house is supposed to have no drains inside of its outer walls. The branch air-pipe from the top of the outgo of the trap is shown branched directly into the soil-pipe for the lower closet as well as for the upper one; but in many cases it is better to carry up, say a 2-in. lead pipe from the lower closet trap up past the upper closet and then branch it into soil-pipe as here shown in Fig. 426, and as also shown in Fig. 461, or else carry the ventilating pipe up through the roof by itself on the principle shown at A, Fig. 187. This, Fig. 426, style of connecting the air-pipe has been in use in Glasgow, especially where the soil-pipe was inside and of iron, for about thirty years back.

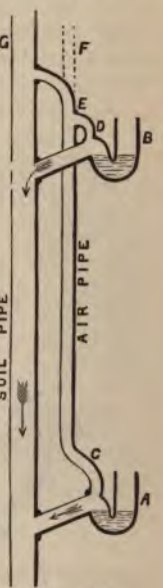


Fig. 426.

I show it in illustration, Fig. 69, of my patent of July 9th, 1878, but I was rather astonished to read some time ago of a person in the United States trying to patent it at the end of 1888 as a new idea of his own, his claim causing some sensation and annoyance there. An attempt was afterwards made to patent it in this country, but it was money wasted, I suppose, as I have never as yet heard any attempt to claim it here. Possibly the patentee, seeing it illustrated in my patent and published elsewhere long before his time, saw that there was no use to try and claim it.

Other ventilating-traps are put on at the foot of the other pipes, as $A^2$, Fig. 425, and U and V, Fig. 424. By thus dividing the house drainage, as it were, into *sections*, only the *minimum* amount of sewage gas is allowed access to any particular pipe, viz.—what is bred in said pipe itself; hence I consider the plan shown in Fig. 424 much safer than the plan advocated, in 1876, by the Local Government Board.

X, Fig. 424, marks where the sewer may be ventilated from, *if desired*, by means of a special pipe carried up to above the roof, but many persons object to ventilate the *public sewer up* their private pipes.

*When either* the soil-pipes or other pipes with branches

leading into the house are allowed to ventilate the common sewer, then the *maximum* amount of sewage gas and danger included is let on to the house.

When the soil-pipe is allowed to ventilate the drain—and the Local Government Board appears to say that it should ventilate as long a portion of the drain as possible—then a *medium* amount of sewage gas and of danger included is let on to the house. But when even the drain is locked off from the house, as in Fig. 424, then supposing something went wrong, only a *minimum* amount of sewage gas can get access to the house, and so the *maximum of safety* exists within it.

Fig. 427 shows vertical section of one of my No. 2 traps (Fig. 415) *in situ*, with the air-opening carried up to the surface to admit fresh air to the drain, soil, or waste-pipe, through the iron grating E, as also shown at G, Fig. 429.* D, Fig. 427, is a plain 4-in. or 6-in.—according to size of trap, &c.—common fire-clay pipe with a branch as at H.

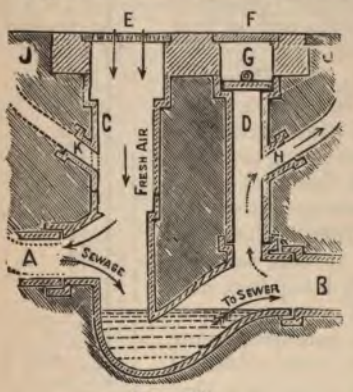


Fig. 427.

This side branch H is for a ventilating-pipe for the sewer to be attached when wished. By this arrangement the vertical opening D remains clear to be used for examination or cleansing of the *outer* side of the trap at a moment's notice and without disturbing the ground, by simply lifting the iron plate F and then the fire-clay lid G, beneath,† the latter being made air-tight with a little lime which is easily removed. In some cases a ring of india-rubber pipe has been used under G. A is a soil-pipe or drain-pipe on the

* In many cases it is preferable—especially where tricky children are about, or people walk over the place—to have a close but movable iron plate at E, and the grating to one side as shown in Figs. 460 and 470, farther on.

† In my own practice I prefer the lid G to be iron, as the fireclay is easily broken.

house side of the trap, K may be a rain-pipe or fresh-air inlet if E be a solid plate, as in Fig. 411. So far as I am aware the arrangement on the outer side of the trap is unique for combined efficiency and simplicity, while the arrangement and practical working as a whole seems much better than where more cumbersome and very much more expensive appliances have been used, and with which the ground has to be opened before getting access to and seeing the outer side of the trap.

If wished, a movable metal grating, perforated or ribbed, or like Fig. 418, may be placed or securely suspended in the pipe D and below the branch H, if any fear is entertained of rats from the sewer getting access to the pipe H.

Instead of setting the trap in the ground as in Fig. 427, it is often, especially where it is extra deep, placed inside a man-hole, as shown in Fig. 428. In this case the outer opening of the trap in the man-hole is generally closed by having the lid cemented down under M; but if it is wished a short branch drain-pipe may be put in as per dotted lines at M, to ventilate the outer side of the trap by a strong iron pipe led up from the side of M at B. If access vertically to the outer side of the trap or drain at N by lifting the lid A is not considered enough, an extra branch with iron lid, as at C, may be used. In my own practice I have not found this extra branch at C necessary. K in this sketch is the drain from the house, Q is the house side of the trap shown open, the arrow at Q indicating the direction of the fresh air which enters down through the iron grating L. In some cases it is not desired to have a grating at L, so a close iron plate may be put on at L, which is easily lifted when wished, and fresh air may be admitted *into* the man-hole by a side air-pipe at S or T, *or as found most* suitable.

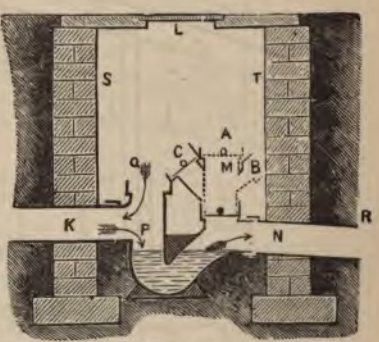


Fig. 428.

*Fig. 429* was an attempted contribution towards a prac-

tical solution of the sewage-gas problem.* It shows a style

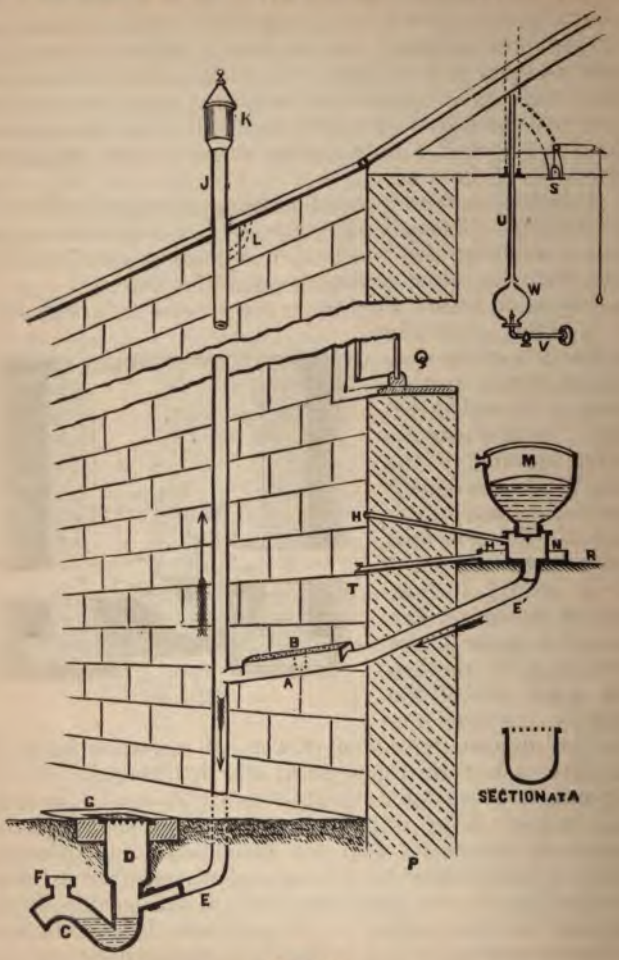



Fig. 429.

*of fitting* up a water-closet, either with or without a lead

* *Fig. 429* is probably nearly perfect, as against mere sewage gas, but as against *dry infected particles*, the open channel, if on a soil pipe

siphon-trap,* which for combined efficiency and simplicity was, some thought, in advance of any plan previously published. The novelty or speciality in it—the open pipe A in the sketch—was suggested by a perusal, about seventeen years ago, of the article on "Sanitary Science," in Blackie's Encyclopædia, by Dr. Robert Bell, F.F.P.S., Glasgow.

My intention in 1874 was to lock off the drain from the soil-pipe and water-closet; but the intention here is to keep out, as far as possible, any gas that may be bred in even the soil-pipe itself from the water-closet. This is effected as shown in sketch.† C is one of my cascade-action ventilating drain-traps. D is the fresh-air entrance channel to the trap and soil-pipe E. This soil-pipe E being surmounted by one of my 4-in. induced-current ventilators K, a constant current of air is expected, and will generally be found to be passing up the soil-pipe. This up current will tend to draw in air from the open channel at A, at the end nearest the soil-pipe; while, if an opening existed in the branch soil-pipe E', no bad air from the upright soil-pipe would get access to the house, but only through the short portion of branch soil-pipe, about 2 ft. long or so, fresh air pouring in from the end of A nearest the water-closet.

Again, owing to the ventilating-pipe H, no bad air could gather in the branch soil-pipe. B is a swinging valve that might be put in if wished of tinned copper, but I consider it unnecessary. M is a Bramah valve closet, but a wash-down

and near a window especially, looks to have an element of imperfection about it, hence many will prefer Fig. 425 with Fig. 460 style. It is difficult to attain absolute perfection in this sublunary sphere; some have boasted of having managed it, but I could never see it as yet.

* I have still a strong fancy for retaining the inside siphon-trap. Mr. James Mactear, when managing partner of St. Rollox Chemical Works, who experimented with water-traps, told me that he easily got the gases to pass through the water, but failed in all his attempts to get ferment germs to pass through. He hoped yet to manage the latter, but his failures hitherto show the value of water in keeping back germs and disease-breeders from the house or inner side of the water trap. The molecules of the gases may pass freely through between the molecules of the water, *and the more readily in imperfectly ventilated pipes*, but the germs, being many times larger, cannot get through in the same way. Experiments made by Dr. Neil Carmichael, and described to the Philosophical Society of Glasgow, in February, 1880, prove this, and see paper by Professor Tyndall, at page 99, vol. xxvii. of the Proceedings of the Royal Society (London), which he *kindly drew my own* attention to. See also page 290 of this book.

† *This plan is* best for closets where there are no room windows near *or close above the* open channel. Compare it with Figs. 407 or 411.

closet would be better. N is the lead safe, with safe-pipe T, carried outside and with hinged valve at its outlet end. R is the level of the floor; Q is the water-closet window; S is a ventilating-shaft for the water-closet enclosure, which may be surmounted by a ventilator. The gas globe W and ventilating-pipe U are more necessary for rooms than W.-C.'s, but put in here merely to illustrate an idea. In some cases the pipe U might be allowed to blow off, as shown; in other cases it would be better to go out as a *small* tube by itself in order to keep up the heat, and so prevent tendency to down-draught.*

Only one water-closet is shown leading into the upright soil-pipe, but several may be led into it, as in flatted houses or large private houses, and by carrying each branch soil-pipe, say, 3 ft. or so along the wall, and leaving about 2 ft. of it open at the top, as shown in section A of the sketch, then each water-closet is locked off from the soil-pipe, so far as the passage back of sewage gas into it is concerned, without interfering with the free passage outwards of the water and soil. J is the soil-pipe continued upwards above the roof, full diameter; L is a rain-water pipe, which in some cases may with perfect propriety be led into it, especially if no windows are near.† Its worst effect is to tend to supply the ventilator with air, instead of the air being forced to come from lower down. It is only ticked in as a suggestion, however, and people can please themselves. The top of the open channel pipe at A is covered with a perforated lead, zinc, or iron grating, as shown at "Section at A," which, while providing for perfectly free ventilation, at same time prevents snow or anything falling into and choking the channel. This grating also prevents the passage of soil down the pipe being seen by any person from a window upon a higher level.

When the smoke-testing of drains and soil-pipes, &c.—introduced by the author in 1875—became popular, this style of open channels on the branch pipes was objected

* In the house I occupied in 1878 I used tubes to carry off the products of gas combustion at the sliding gasalier in the dining-room; the tubes working up and down with the gasalier. This kept the air *of the room* pure when the gas was lighted. A fixed tube served for *the kitchen*. Electric light may by-and-by obviate all this; but with *electric lights* ventilation is needed to carry off the heat.

† *And the slates are not hanging over the mouth of the pipe, but some distance off.*

to as tending to make it more difficult to test the pipes in side, as when the smoke was applied into the trap D, Fig. 429, it came out at the open channels, which, if high up, might be difficult to get at to paste up when testing.

The style, such as shown in Fig. 430, is that therefore preferred, viz., with all the branch pipes air-tight, and then the smoke should only come out at the air-pipe V—unless when the air-pipe off the top of the outgo of the inside traps is carried up above the roof separately.

This sketch, Fig. 430, represents the way in which the waste-pipes from the kitchen-sinks are now trapped off from the drain in many of the flatted tenement houses in Glasgow.

In this case, the vertical 3-in. iron pipe I, has the branch waste-pipes from six kitchen-sinks coming into it. It delivers into a 4-in. disconnecting trap T at its foot. This trap has an iron access-plate P above it, while to one side there is the fresh-air inlet grating A.* The outlet is above roof at V, with or without an exhaust ventilator on its top.

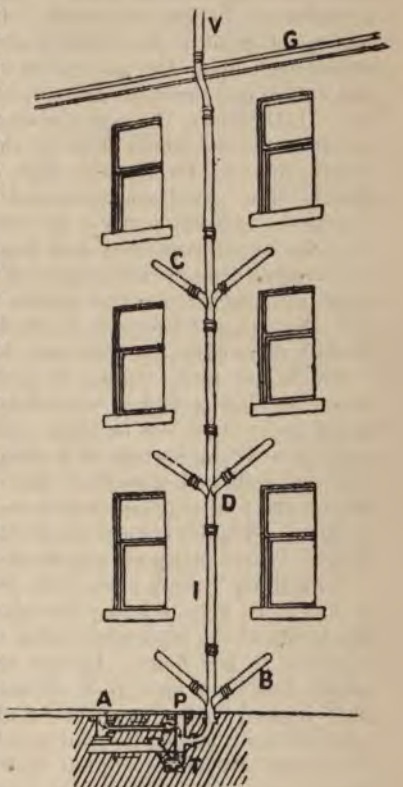


Fig. 430.

At page 382 of the *Sanitary Record* (London) for June 15th, 1877, reference is made to a paper communicated by

* *Other examples of side fresh-air inlets will be seen at Figs. 460, 469 and 470, farther on.* Also see F G S and T, Fig. 471.

Professor E. Frankland to the Royal Society, "On the Transport of Solid and Liquid Particles in Sewer Gases."

In his paper Professor Frankland says, "It is, therefore, extremely improbable that the mere flow of foul liquid through sewers can impregnate the circumambient air with suspended particles;" but after explaining certain experiments he goes on to say, "Here, then, in the breaking up of minute gas bubbles on the surface of a liquid consequent upon the generation of gas within the body of the liquid, is a cause of the suspension of particles in the air. If, therefore, through the stagnation of sewage or constructive defects which allow of the retention of excrementitious matters for several days in a sewer, putrefaction sets in, then gases are generated, and the dispersion into the air of zymotic matters is very probable. It is of the greatest importance that foul liquids should pass rapidly and freely through drain-pipes and sewers, so as to secure their discharge from the system before putrefaction sets in." See pages 542—545 of the Proceedings of the Royal Society of London, for February 8th, 1877.*

One lesson to be drawn in practice from these experiments is that a siphon water-trap with a small body of water in it, which can be often easily renewed, is safer upon a drain or at the bottom of a soil-pipe than a large pit cesspool, the influx of even clean water into which often merely dilutes the foul stagnant water, and stirring it up, causes it to throw off more sewage gas bubbles than in the quiescent state. Water in a good siphon trap acts as a filter.

"Flushing" drain-pipes with *foul* water has an element of evil in it, as said foul water leaves a dirty deposit upon the inside of the pipe, which after drying may allow disease particles to get loose. In this connection when a drain which has been choked is cleared, it should not only be well flushed with clean water and disinfecting liquid, say muriatic acid, but its interior should also be fumigated with the fumes of burning sulphur blown into it, as the flushing liquid may only cleanse the lower half of the pipe, and leave the top half still dirty. The neglect of proper flushing and fumigation may, in some instances, lead to develop-

* *If sewage* is really to be rapidly carried entirely away from the *house sufficient* water must be allowed to do so. Preaching as above *does little* if any good unless it can enlarge the paltry two-gallon *water-flush* for closets into four gallons, or more.

ment of cases of diphtheria, especially should children come under the influence of the atmosphere from the drying and stinking drain.

Amongst the pseudo-improvements in house drainage suggested within the last few years by non-practical men, I here give sketch of one that was highly puffed up in the professional journals about the beginning of A.D. 1880. In this case a disconnecting trap is put on at the bottom of the soil-pipe to lock off the sewer gases, rats, &c., but any good it could do in that respect is completely stultified by the air-pipe put in from the *outer* side of the trap and connected to the air-pipe of the soil-pipe *inside* of the house!

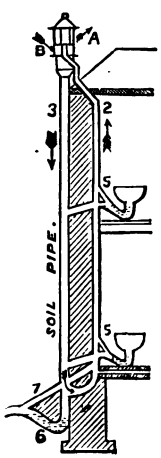


Fig. 431.

How the genius of the author of this grand design managed to throw such a glamour over the brains of the critics as to cause them to praise up such an absurdity is a curious problem in our nineteenth-century journalism. It is only one, however, amongst various foolish plans that have been promulgated and extolled through the press, and it should serve as a lesson to the public not to take as gospel all that appears in print. It also suggests the question: Supposing the author of such a design were really entrusted with some large job where more elaborate combinations of pipes were used, how many dangerous mistakes might really be made? The only chance of good work from an amateur plumber is where the work is sublet by him to a properly qualified practical man, to whom, however, it might be better to go direct. There is not much to be gained by incompetent or nominal supervision, although really good and honest superintendence or inspection is worth paying for when required, as it often is.

## CHAPTER XXXII.

### General Drainage and Ventilation.

Before bringing our remarks to a close we may add some further information relative to the proper laying down of drains within and around houses, &c., and also as to the ventilation of buildings. Wherever the drains are well laid, securely jointed, and properly trapped and ventilated, it is a great benefit to the house and also a great boon to the inmates; but if otherwise, the house is damaged, and

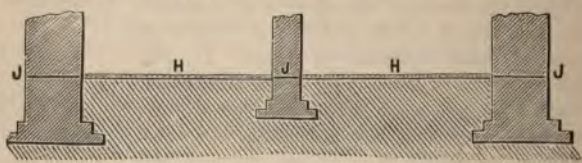



Fig. 432.

its occupants often seriously injured or killed. In the lower flat, the plaster on the walls may often be seen damp and bulged out in a very unsightly manner for several feet up,*

* In country houses, with the water supply derived from wells, disease and death are often produced owing to leakage from bad drains or dirty slops, &c., thrown on the ground getting into the wells. The water moving in a circle—well, cistern, stomach, drain; and well, cistern, stomach, drain, again, for so much of the same. In such circumstances people should be careful whom they invite to the house, for a diseased visitor might damage the whole family! Then, again, it is anything but a friendly act to invite a friend to stay at one's house *where either* the interior atmosphere or the water supply is polluted *by the sewage.* Town dungsteads used as manure on fields sometimes *pollute the* water supply. Dr. Ebenezer Duncan of Glasgow gives a *very interesting* and instructive example of this in the "Transactions *of the Philosophical* Society of Glasgow," March, 1881.

a signal that the house in that part at least is in anything but a healthy condition.

To prevent dampness in the lower flat and the damp rising up the walls, the following plan ought to be strictly enforced by all authorities, viz., when the walls are being built to lay down a layer, a little broader than the wall, either of 4 lb. sheet lead, or of slates bedded in cement, or, especially for the outer walls, of Caithness pavement, said layer being put in either at the same level as the asphalt, as per Fig. 432, or otherwise as may be most suitable.

In Fig. 432, H H is the asphalt, and J J J the layer of lead.*

Above the asphalt a layer of Caithness pavement may be put down if wished, especially for the kitchen and lobbies: but where pavement is not wanted small wooden joists may be put in on the top of the asphalt, and then wooden flooring laid down, while the space between the underside of the flooring and the asphalt could easily be ventilated by holes cut through the outer walls and perforated iron gratings put in.† If the ground is very damp, or a spring exists about it, drain-tiles should be put in or other provision made to carry off the water, and the work so executed as that neither bad air nor rats can get into the house.

As disease and premature death are now considered by educated people, and, in fact, have been proved to be due to purely natural causes, it is the province of the sanitary engineer to do what he can in his own sphere to guard against or remove these causes. The time has gone past for either sympathising with or allowing foolish fatalism to sit with folded hands and stupid superstitious resignation in the midst of unhygienic surroundings. As emphasising the value of giving plenty of ventilation underneath the flooring in ground flat houses, reference may be made to

* Pettenkofer's experiments as to the permeability of walls, or the passage of air and gases through bricks, sandstone, concrete, &c., are worth remembering here. See p. 410 of the *Sanitary Record* (London) for December 28th, 1877. See also remarks on Ground Air and Dampness, by Dr. B. W. Richardson, in the Introduction to "Our Homes, and How to Make them Healthy," a capital book lately published by Messrs. Cassell, Petter, Galpin, & Co., London.

† Through and through ventilation, with a sufficient number of openings (more smaller openings are better than few large ones) is a *great preventive* of "dry rot"; currents of fresh air playing around *wood being unfavourable* to the growth of such fungi as the *Merulius lacrymans*.

the deaths from suffocation by coal gas, as by the breaking of the gas-pipe G underneath the pavement P in Fig. 433. With the wall of the building W W, below the level of the pavement, built of rubble stones, gas escaping from the pipe G can, generally speaking, easily get through said wall W W, and all the readier fill the space below the flooring F, if the ground B B is not asphalted. When the gas gets into the space below the flooring it soon rises up round about it into the apartment above. If, however, the space below the flooring is well ventilated by sufficient and large enough openings in the walls, as indicated at A A, then the escaping gas gets diluted, and so may rise up into the apartments in sufficient strength to alarm the inmates without suffocating them. As a still further precaution to the passage of escaping gas from pipe G into the building, if the outside of the wall at C from the pavement level to the foundation be cemented, it will be more difficult for gas to pass into the building.

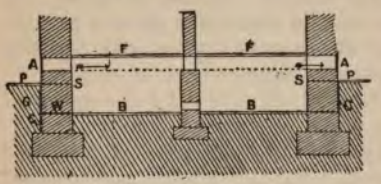



Fig. 433.

The absence of precautions such as these was probably the cause of the deaths of whole families from suffocation

Fig. 444.

Fig. 445.

by gas escaping from a gas-pipe situated as at G, which had got broken under the pavement.*

*This suggests* also that an outlook should be kept for un-

* *Since writing* above another family, in different place, had several *members nearly* killed by gas escaping outside their house coming in *to them.*

necessary holes through the walls of buildings below the ground, and especially next the street.

The dirty habits of our progenitors were often the cause of disease, while, as regards drainage, its absence, or the bad planning and often equally bad workmanship of what was attempted, were continuously productive of evil.

Where houses had drains these were made of stones, often a flat stone bottom and irregularly filled-in stones at the sides, as per sketch, Fig. 444, through which the rats had often free access to the interior of the house.

An improvement was made when the stone channel at bottom was hollowed out and the size of the drain lessened, and especially when it was better built, as per Fig. 445.

Sometimes the drain was cut in the solid rock, as per Fig. 446 (which shows vertical cross section), and large enough for a man to walk through. In doing so one had to watch not to get soaked or befouled by the discharge from the soil-pipe S in passing.

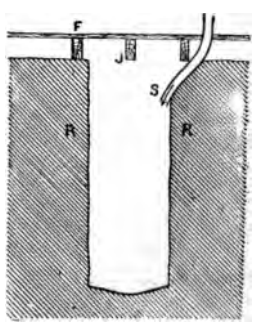



Fig. 446.

These rock-cut drains often passed through the middle of the house, the dining-table, perhaps, resting upon the floor F, right over or adjacent to the drain! The regular occupants of the house may have felt nothing definitely wrong for years (or at least the governor wouldn't admit it), while visitors might sometimes lose their appetites or sicken in a few days. In some cases, however, it has been the owners themselves that suffered; delay in rectifying the drainage clearing the way for the new and at one time improbable-looking heir.

It is not genuine hospitality to invite either friends or acquaintances to stay in insanitary dwellings. To do such intentionally in the hope that evil might come to them, would be equivalent to administering poison.

*In connection* with these built drains large built cesspools —*Fig. 447 gives* longitudinal vertical section of one—were *often set down* between the house and the outfall of the

drain, whether that outfall were a street sewer, a stream, or a field.

In a number of cases cesspools were set down inside the walls of the house. This was ignorance, in giving trade to both the mason and the undertaker, virtually digging a grave for itself.

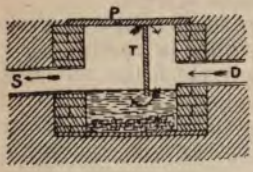



Fig. 447.

When the smoke-test is applied into the sewer or outlet end of the drain, as at S, Fig. 447, the smoke often easily gets into the house-side of drain D, either over the top of the "tongue" or dipping-stone T, or round its end or otherwise. When cesspools are either retained or put in now, the dipping-tongue may be dispensed with, and a disconnecting-trap, such as a Buchan's No. 2, or No. 8 trap, put on the drain from the house as at T, Fig. 448, which shows a rough ground plan.

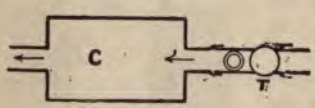



Fig. 448.

In cases where it is desired to have the outflow from the cesspool purer than ordinarily, settling chambers are sometimes put in as at U U U, Fig. 449. The three upright division-stones are set quite level across, while they are also about the same height; the difference being that the one nearest the tongue T is a shade higher—say ½ in.—than the one beyond it, and so with the next one. The outlet at S is preferably about 3 in. lower than the inlet at D.

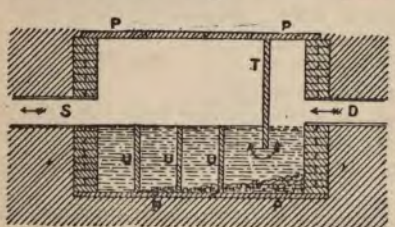



Fig. 449.

For general house use the spigot and faucet style of vitrified fire-clay drain-pipe shown in Fig. 450, if good, makes a very serviceable pipe, for ordinary purposes, if it is properly laid and securely and smoothly jointed. They are made in lengths about 3 ft. long or under, and may be had

of various sizes, say from 4 in. in diameter upwards. The smallest size in general use * for the main drain of a house is 6 in., which size, with a fall of 1 in. in 40, or more, will run off a great deal of ordinary house sewage and rain-water, especially if the pipes are smooth inside and laid regularly, and all the joints well cleaned off in the inside with a scraper. This scraper —which may only be a half-circled piece of wood, about 1 in. thick, with a handle attached about 3 ft. long or so to suit the length of the pipe—must be so made as that its edge will not sink into the joint when being drawn across it. Nine-inch diameter pipes are often used where 6-in. or at most 7-in. would serve far better and also be cheaper.

Fig. 450.

One mode of jointing the pipes is to pack the joints well with clay. This often does pretty well, if properly done, where the ground is not very firm, as it allows the joints to yield a little without breaking; † but where the ground is solid, and the pipes can be laid down without fear of sinking, then I prefer the joints made with either Roman or Portland cement, and plenty of it used.‡ Some use gascon or hemp; but the joint filled full of cement and cleaned flush inside does well. For all side connections I generally prefer branch pipes to be used, the branches being inclined to suit the run of the pipe, as per L, Fig. 472; the angular branch not being so apt to cause a chokage as the square one.

In practice I often found the plain round pipe, Fig. 450, wanted something to enable a first-class job to be easily made, and also to prevent liability of disturbance of the

* I have often had a fancy to see 5-in. drain pipes come into use in many cases in place of 6-in.

† An objection to soft material for jointing is that it is boreable by worms or the roots of trees; in some cases the latter have completely filled up the pipe. The Roman cement sets quicker but is not so hard.

‡ If at all possible no drain-pipes should be laid down in the interior of a house. Where drain-pipes must pass through a house, some support the use of sufficiently strong iron pipes, the joints of which may be run with lead, while special eyes could be put in, say every eight feet or so, to serve as access openings; but for those who prefer the fire-clay pipe the improved pipe with rest, and with longitudinal access-openings at suitable distances, shown in Figs. 451, 452, and 471, may be used, and the pipes laid upon and surrounded by concrete.

pipes and breakage of the joints before they were set, from rolling of the pipe owing to its being round. To rectify this I invented and patented an improved fire-clay or stoneware pipe with a flat sole or feet, which flat sole prevents the pipe from rolling. Then in order to enable the bottom of the joint to be more easily and securely made, this flat sole projects a little beyond the faucet and a little back from its front edge, which allows the hand or tool to be got in *under the joint* and front of faucet, and so while easily putting in the necessary cement at the bottom to also wipe off the surplus properly to edge of the faucet, and so make a tight joint. This is found especially useful when the drain-pipes are laid upon either a stone, cement, or concrete bed. Further, where the drain-pipe is to be cemented or concreted either half-way up or all over, the style of the flat sole or rest allows this to be easily and well done. See other style of the pipe, Fig. 452.

Again, in laying down drain-pipes I often wished to be able to look along the inside of the pipes before they were covered in to see if they were all clear *inside*, but with the ordinary pipes below 9 in. diameter, although the usual round eyes the full size of the pipe might be put in, they were too small to let the head in, consequently to get over this objection, while patenting the above pipe with the flat raised sole or feet, I at the same time introduced and patented a *longitudinal* access opening, with longitudinal movable lid, which opening, while being the full breadth of the pipe at least, is made two or more times as long, and so allows the head to be got easily in to look along the inside of the pipe; a lighted candle being held down at another opening or down the cleansing eye of my disconnecting trap, the state of the interior of the pipe can be easily seen.

Should it be necessary to put in a rod or long cane to clear the pipe such can be far more easily put in into a longitudinal opening 18 in. or more long than into a round hole only about 6 in. diameter.

Figs. 451 and 452 give longitudinal and cross vertical sections of these improved pipes, which are supplied by *Messrs.* J. and M. Craig, of Kilmarnock, the makers of *my traps, who* are the sole manufacturers. They have *agents and* depôts throughout the kingdom so as to *supply them* readily. They received award of merit at *the International* Medical and Sanitary Exhibition, Lon-

don, 1881, and from the Sanitary Institute of Great Britain, &c.*

A, B, and D are views of the attached flat sole, which may extend along the pipe any length. C is a movable flat sole

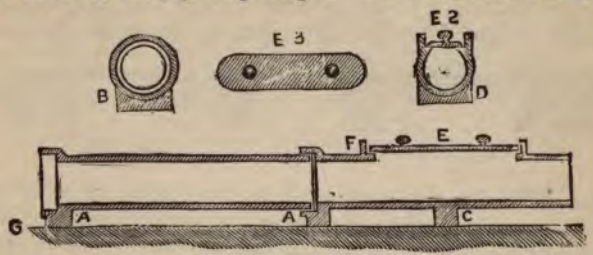



Fig. 451.

block, which may be used when the attached block is short, as shown at A. E is the iron lid for the opening, which, in its place, may be made tight either with lime or with lime or sand and a thin coat of cement on top, as most suitable. Some use red lead putty for the iron lids. When the pipe is not to be concreted below it, the earth is simply packed in under and around the pipe.

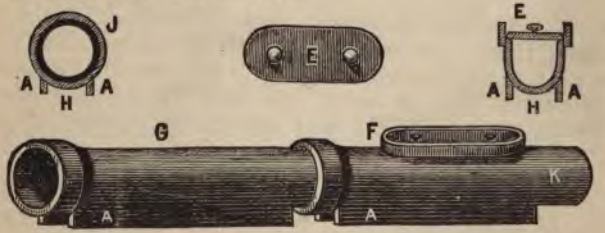



Fig. 452.

In Fig. 452 two long ribs A A are used instead of the solid block. When wished and for greater strength, the

* These pipes have been used *inter alia* by myself in work done for Messrs. Campbell Douglas and Sellars, architects, Glasgow, as at Achna-Cloich, on Loch Etive, and for Mr. John Honeyman, F.R.I.B.A., at Craigton Castle, Stirlingshire: likewise for Mr. James Thomson, F.R.I.B.A., Glasgow. They were also used by Messrs. Watt and *Wilson, with consent of the architect, at the new Central Railway Station, Glasgow.* Mr. Thomas Watson, architect, Glasgow, is using *them for the drainage of new Board Schools, and so at many other places.*

space H between the ribs may be filled with Portland cement before laying. This is an extra strong drain-pipe, and very useful for laying on earth or soft ground. See Figs. 471 to 474 for branch access-pipes and bends.

Figs. 453 and 454 are vertical sections of square fire-clay blocks suitable for either iron gratings or plates to be set

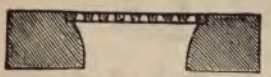


Fig. 453.

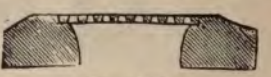


Fig. 454.

into. The former is intended for level ground, or for asphalt or cement; the latter for gravel or for grass. Fig. 455 is vertical section of square *iron* box frame which I often use in place of the fire-clay blocks; the margin outside of the grating being much less it looks neater. Fig. 456 is

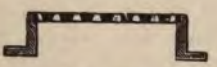


Fig. 455.

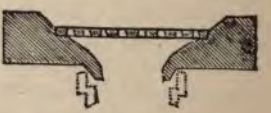


Fig. 456.

one of my square slop-stones made of fire-clay, 1 ft. 6 in. across. It has a projection or pap at the bottom, to fit into the pipe, so as to prevent soakage of the ground. Fig. 457 is horizontal plan of one of the strong cast-iron gratings referred to at page 258 (and also shown in Figs. 453 to

Fig. 457.

Fig. 458.

*458), the* size in this case being taken as 10 in. (See p. *328.)*

*A very* common practice exists regarding the drainage of *wash-houses*—which I have condemned very strongly, *especially where the* wash-house is within the walls of the build-

ing. I allude to the use of those iron "bell traps" with the movable covers. They readily choke up, and so the cover is taken off, or lifted, to cleanse them out, when up comes a rush of sewage gas from the drain and passes up through the house. The covers are also often left off. None such should be put in, but, instead, a 4-in. fire-clay siphon-trap (the same shape as the plumber's lead one), with an iron grating, and slop-stone above it, as shown in Fig. 458, which combination I have termed "The Anti-Bell Trap."

Fig. 428 shows vertical section of a No. 2 Buchan's disconnecting trap placed inside a single manhole. I have done so as occasion needed for a number of years back. I have likewise used two manholes, as shown in Fig. 459, viz., one on the house side of the main trap and one on the sewer side of the trap.

In this case the new access-pipe shown in Fig. 451 was also introduced, the pipe on house side of trap having the access opening without the lid as seen at B, Fig. 459, so

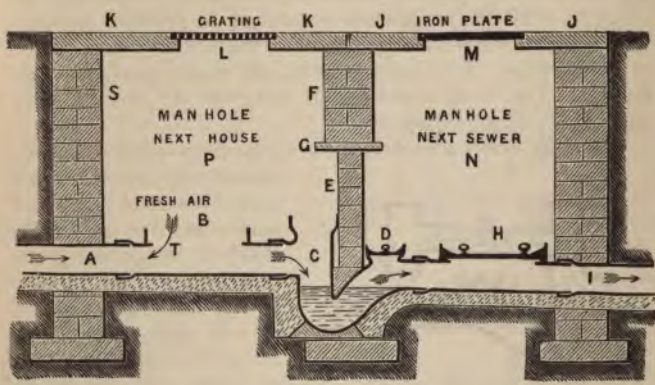



Fig. 459.

that in this case the access opening acts as the fresh-air inlet to the drain as per the arrow T. The access opening beyond the trap has the lid on and cemented down as shown at H, but when desired the lid may be lifted to examine or clear the drain. The lids as sent out at first were of fire-clay, but purchasers should insist on iron lids as being stronger. If it is wished to ventilate the sewer sid

of the drain this may be done at the branch or eye D; and as stated at Fig. 428, if it is not wished to have an inlet grating right over manhole as at L, it may be placed at any convenient distance and an air-pipe led to S on a similar principle to Fig. 460.

At one large mansion-house in Stirlingshire ("Craigton," near Fintry), where Fig. 459 style of fitting in the *main trap* has been adopted (in this case the trap is a 9-in. one), there are other fifty disconnecting ventilating traps on the branch drains, viz. 4 in. and 6 in., No. 2, so that supposing the trap C from any cause failed to lock off the sewer gas from the drain I, each branch trap would still act as a barrier to it getting into the house-pipes. The air which enters at L and B after traversing drain A, goes up a special 4½ in. strong iron ventilating shaft carried above the roof and surmounted by one of my 10-in. Induced-Current Fixed Ventilators. The pipes were laid on a bed of concrete and after being jointed with cement were concreted half-way up, but any portion of drain passing inside any enclosure was concreted all over. All the traps were concreted to prevent leakage. The holes in walls through which either drain-pipes, or soil or waste-pipes, &c., passed, were all made good with cement.* The work was done to order of Mr. John Honeyman, F.R.I.B.A., Glasgow.

Fig. 460 shows a modification of the fresh-air inlet to the ventilating-trap, when said trap is too near a door.† It is also useful in preventing children dropping pieces of wood, &c., into the trap. In this case a square branch or eye pipe, C, is put in above the trap, and a pipe, D, joined to it and turned in any direction as most suitable. B is the iron grating for admitting fresh air, while the top of the trap is in this case covered by an iron

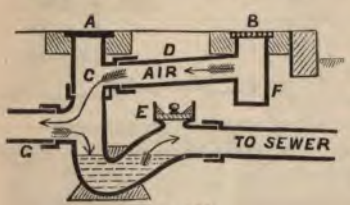


Fig. 460.

* This is an important point not only in order to prevent any gases *or bad air getting* into the houses along the outside of the pipes, but *also to keep out* rats or other vermin, should such visit the neighbourhood.

† *This side* fresh-air inlet is coming into much more general use as its *value is being* understood, not only for preventing chokage of trap, *as stated, but* also for preventing temporary puffs-out of smell when a

plate A. The grating B may also be set in plumb in face of a wall, the pipe D being carried forward and bent up to suit the locality of the grating. See also Fig. 419.

Fig. 461 shows in vertical section the general arrangements for providing, in a satisfactory, safe, and simple manner, for the water supply and drainage of a house. This diagram may be studied in connection with Figs. 415, 424, 425, 426, 427, 428, 430, 451, 459, 460, 462, 463, and 471.

The trap marked $A^2$ $B^2$ shows how I have been in the habit of trapping off the soil-pipe from the drain, while at the same time providing for the proper ventilation of both soil-pipe and drain. This trap is the same as that shown at Fig. 415. The size in this position is generally 6 inches, which size costs about nine shillings, 4-in. size less, and 9-in. more. C and D are two of my Induced-Current Fixed Ventilators.* E is the overflow pipe of the clean water cistern, with one of my self-acting block-tin bell traps in the cistern. K is one of my blow-in glycerine jointed cowls, shown here upon the supposed high-level inlet ventilating pipe for drain. I have never as yet, however, required to put up this high-level inlet pipe *so surmounted* upon any of my jobs; although I have used a plain vertical inlet pipe 6 feet or more high. The dotted line H indicates another style of overflow pipe for the water-closet cistern. Seeing that Fig. 200 bell-trap is not used, it should have a hinged valve at its outlet end. G is clean cold-water supply off the main to sink and bedroom on lower flats. On top flat the fresh water is shown from a cistern. J is a water-closet trap, with the safe as usual *above* it, and upon the floor, but under the water-closet. This trap J may have a sheet-copper bottom added on it, to prevent it being holed by a lazy servant, say, poking it to get rid of something that should not have been put down.

The trap A is the ventilating-trap dividing the house drain from the sewer; the opening at A is a strong perforated or ribbed iron grating—I prefer and use the former—for the

closet is let off, or a wind wave acts with exhaust power on the grating. It being much more difficult for smell to get out at B than with the grating at A, because all the fresh air in the pipe, D, has first to be pushed or sucked out, and this pipe, D, may be either one, two, or three, or more yards in length. While I have been recommending and *using this side* fresh-air inlet for about a dozen years back, a party has *lately applied* for a patent for it, as if it were an A.D. 1893 novelty!

* *Cost of* these, according to size, from twelve shillings each upwards.

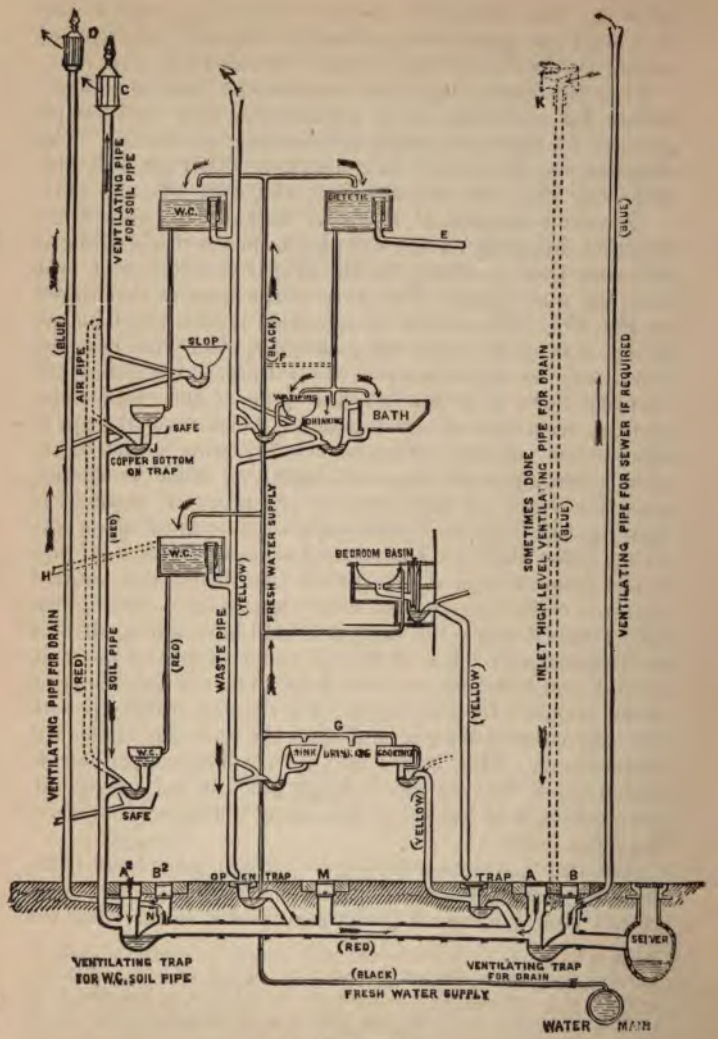



Fig. 461.

admission of fresh air. It is easily removed in order to

examine or clean the trap. B is the examination or cleansing eye on the outer side of the trap. It is covered by an iron plate, having a cemented-in fire-clay or iron lid beneath to prevent the sewer gas coming out.

The ventilating pipe from the sewer, as at L—or for the drain as at N—is connected to and led off from the *side branch* attached to the vertical pipe. This plan, while allowing full and free scope for ventilation, provides for ready examination of or easy accessibility to outer end of trap at a moment's notice, without disturbance of or lifting the ground. The plan was patented by me, but is freely open to be used by all parties using my No. 2 ventilating traps.

I do not here enter into the question or propriety of ventilating the public sewers up private pipes; I only here show what I consider the best mode of attachment when it is done. M is a cleaning or examination opening upon the drain, with iron plate and cast-iron lid underneath, the latter being cemented down.

My patent pipe,* see Figs. 451 and 472, with the longitudinal access opening and lid, is in many cases the best to use for this. The space between pipe and surface of the ground may be built with bricks and cement, and have an iron plate on top like J, Fig. 351.

Instead of the kitchen sink discharging into a disconnecting siphon-trap, as into one of my No. 2 traps, it may discharge into one of my patent grease-traps illustrated and described and shown in position at H, Fig. 471, and Figs. 350 and 351 *ante*.

Fig. 462 shows a ground plan of the drainage of Armadale Castle, in the Isle of Skye, as altered and improved by me on the Sectional System in the spring of 1887, for the Right Hon. Lord Macdonald of the Isles. A, B, C, D, and E are closet soil-pipes inside of the house, with separate Buchan's 6 in. No. 2 disconnecting traps F, G, H, I and J outside for each. These latter traps have side fresh-air inlets as indicated, and as was illustrated on page 302. In the case of F trap the outside rain pipe "8" acts as the fresh-air inlet.

* In "L'Hygiène dans la construction des habitations privées," published by Professor F. Putzeys, of Liège, assisted by Lieut. E. Putzeys, *these traps* and pipes are illustrated and recommended, and *so are the wash-down* closets. My fixed ventilators are also illustrated *in three styles.*

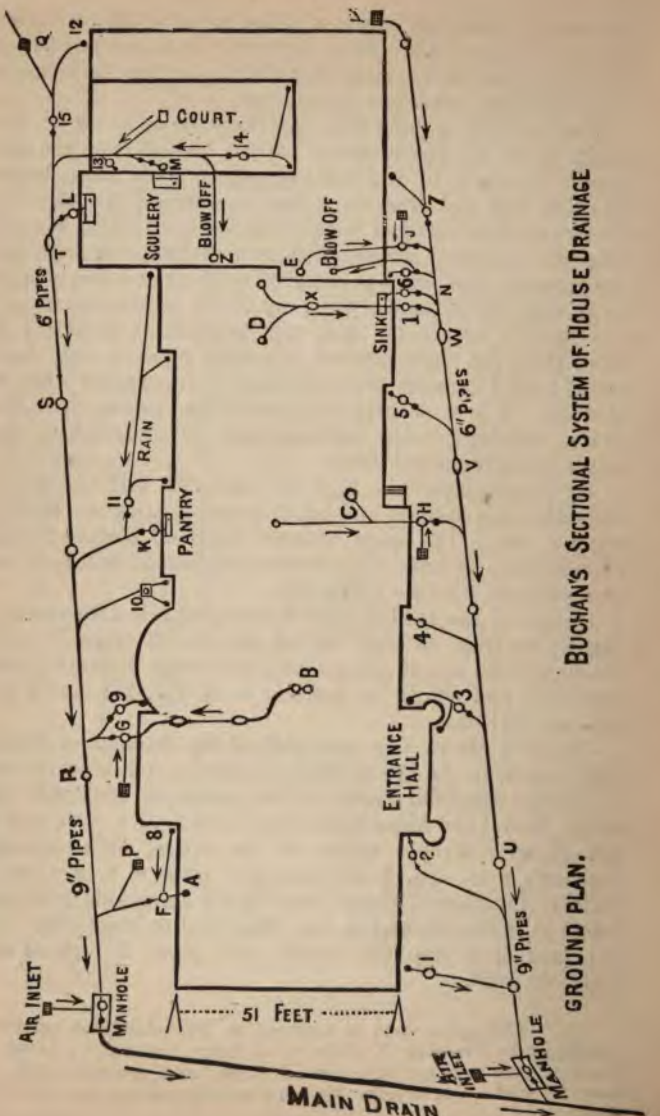

COURT.
SCULLERY
BLOW OFF
BLOW OFF
SINK
6" PIPES
RAIN
PANTRY
6" PIPES
ENTRANCE HALL
9" PIPES
9" PIPES
AIR INLET
MANHOLE
51 FEET
AIR INLET
MANHOLE
MAIN DRAIN
BUCHAN'S SECTIONAL SYSTEM OF HOUSE DRAINAGE
GROUND PLAN.

Fig. 462.

Where the drain pipes enter the house as at B, C, and D, they are laid on and surrounded by concrete, and have my access pipes with iron lids for easy examination, &c., when wished, without disturbing the pipes; most of the rain pipes are trapped at foot separately; but No. "11" trap serves for three rain pipes. The scullery sink has a Buchan's grease-trap M set outside in the court, in style shown in Fig. 351. The other sinks are also trapped outside separately.

The drains going along the front of the house are kept distinct from those going along the back by the two 9 in. No. 2 Buchan's traps in the manholes. The fresh air enters each manhole from the side fresh-air inlet, and after passing along the inside of the drain goes up the two blow-off pipes, which are carried up above highest vents and each blow-off pipe surmounted by the No. 1, I.-C. fixed ventilator, Fig. 489.

The traps marked "7" in front and "15" and "14" at back prevent bad air getting behind them. The soil-pipes A, B, C, D and E are each ventilated separately to above the roof. The blow-off pipe Z is 4½ in. diameter inside, and the other one 4 in. Both are of strong iron soil-pipe pattern, and are red-leaded inside to prevent them rusting up. The outlet eye of the No. 2 trap in each manhole has a lid sealed down with lime and a little Roman cement on top, so that access to outer end of trap can easily be got when wished. It does not do to use Portland cement to seal down these access lids, as it gets too hard. The "main drain" in this case is a built one, discharging into the sea; it was not considered necessary to put up a ventilating blow-off pipe for it as it is not air-tight. If pipes are put in for the main drain at a future time, a blow-off pipe might then be put up from off side of the outer eye of the trap in the upper manhole, in style indicated at M, Fig. 428.

In lifting the sealed-down lid on the outer end of a trap *in a manhole*, the tradesman or person doing so should take precautions not to get asphyxiated by a rush up of bad air. To prevent this the person might simply loosen the lid, and, having fixed a cord to it, go out of the manhole and then pull off the lid, and then allow sufficient time, according to circumstances, for ventilation before going back into the manhole. See page 238.

Fig. 463 is a ground plan of Belmont Castle, almost *entirely rebuilt* and enlarged in 1887 from plans by James *Thomson, Esq.*, F.R.I.B.A., architect, Glasgow, for the Right

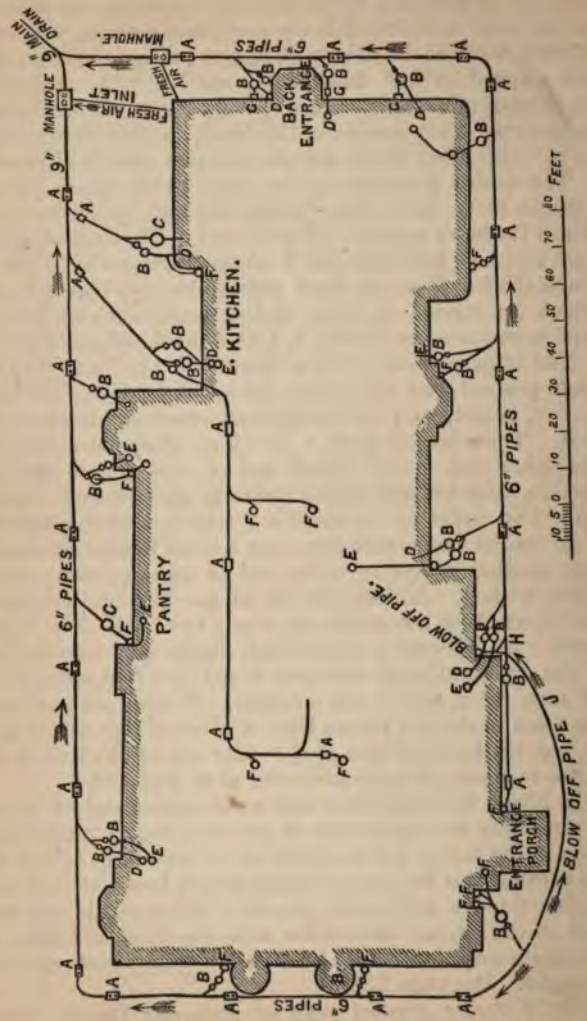

MAIN DRAIN
MANHOLE.
FRESH AIR INLET
MANHOLE
6" PIPES
BACK ENTRANCE
E. KITCHEN.
PANTRY
6" PIPES
6" PIPES
BLOW OFF PIPE.
ENTRANCE PORCH
BLOW OFF PIPE J
FEET

Fig. 463.

Hon. Henry Campbell-Bannerman, M.P. The drainage, as seen, has been carried out by Mr. Thomson on the Sectional System; all the soil-pipes, waste-pipes, and rain-water pipes being disconnected from the drains. A on the 6-inch pipes indicates my patent access pipes, with longitudinal openings on top and iron lid.*

B shows position of the No. 2 Buchan's disconnecting traps. C is the grease-trap (shown at Fig. 351) for sink. D indicates the soil-pipes; E waste-pipes for baths, basins, and sinks; F, rain-water pipes. The four rain-pipes and their drain inside of the house are kept clear of sewage gas by the Buchan's disconnecting trap set outside. J is the ventilating blow-off pipe for the drain along front of house, and H the blow-off pipe for the drain along the back. The two join into one blow-off near H, which is carried up to the top of a high tower, where it is surmounted by one of my No 1, Fig. 489, fixed ventilators. There is a Buchan's disconnecting trap in each of the two manholes. There are access pipes every 40 feet or so on the main drain. Gartshore House, recently rebuilt by Mr. Thomson for Alexander Whitelaw, Esq., has its drainage on the Sectional System. Likewise Tulliechewan Castle, James Campbell, Esq., and Stracathro House, for James A. Campbell, Esq., M.P. Also Moy Hall, Inverness-shire, and "Cottrell," near Cardiff, for The Mackintosh of Mackintosh, "Woodbank," Balloch, for W. E. Gilmour, Esq., Dalton Tower, Westmoreland, and many other mansions and houses, &c., throughout the kingdom.

In executing the drainage of Armadale Castle and Belmont Castle, the blow-off pipes of the drains are placed at the high end of the drains, so that the current of air through the pipes may go in the opposite direction from the water.

In Figs. 464 and 465, however, the air and the water-currents are intended to both go in the same direction. C and D, Fig. 464, are blow-off pipes for the drains. The fresh air for C drain entering at the grating A on the ground, which may have a light self-acting valve under it, as per V, Fig. 420, to let air in but none out. D has its fresh-air inlet from the pipe B, whose top is 6 feet or more above the ground. Fig. 465 is from my patent of March 22nd, 1883. *Several* persons since then have published the same *plan as novel* and grand, but they were too late to claim it.

* *Every proprietor* of a house should have a plan of its drains.

as new. In Fig. 465 both covers above the trap are solid iron plates.

In the article on Sewerage in the new edition of the "Encyclopædia Britannica," Professor J. A. Ewing, F.R.S., illustrates the Buchan traps, and acknowledges the "excellent service to the cause of sanitary reform rendered by

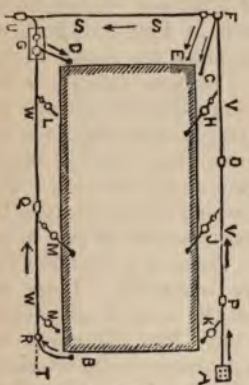



Fig. 464.

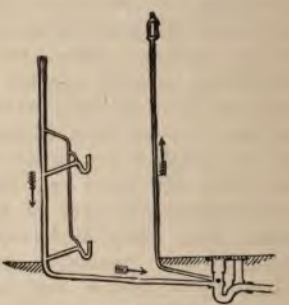


Fig. 465.

the disconnection and ventilation of house-drains and soil-pipes on the principle which Mr. Buchan has advocated."

Mr. A. Lindsay Miller, architect, Glasgow, says the introduction of the Buchan trap, shown on page 270, and the system of ventilation inaugurated therewith, have done more for the advancement of house drainage than all other appliances put together.

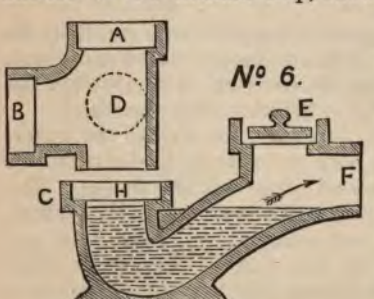



*Fig. 466.*

Mr. James Sellars, I.A., architect of the buildings, etc., for the International Exhibition, Glasgow, 1888, permits me to state that his firm are in the habit of specifying Buchan's *appliances* for their drainage work, and did so for the *Exhibition* drainage; the main disconnecting trap speci-

fied for insertion on the drain between the public sewer and the buildings being a 15-inch Buchan's trap.

I here give some illustrations of the traps in two pieces. Fig. 466 shows a Buchan's trap, No. 2 style, in two pieces —termed "No. 6"—with the well H of the trap the same diameter as the inlet branch B, and the outlet end F. The part A B being movable, the branch inlet B can be turned round in any direction. Sometimes a second inlet branch is put on as indicated at D, which may be used either for water or air. In other cases there may be three or more inlets. In my own work I have seldom used more than one waste-water inlet branch into the same trap, and especially for drains.

Where the drains have been deep I have sometimes made one main trap receive one or two side drains as well as the drain behind it, in order to have only one deep manhole, or save expense, &c. In the case of trapping and ventilating street sewers in sections, which may yet become much more common than at present, it might be often useful, to save expense, to use traps with two or three inlets, as indicated in my patent of A.D. 1883, and as illustrated farther on; only, of course, when the one trap is made to serve for two or more drains the aerial disconnection is not so complete as when each branch drain or branch sewer has its own trap.

Fig. 467 shows another idea of mine introduced about A.D. 1880, viz. contracting the well H of the trap to about one-third or more less than the inlet and outlet.* This is often done for sizes from 6 in. upwards, in order to make the trap more self-cleansing by having less surface of water at H. The value of having a small surface of water exposed in the well (H) of the trap is indeed strongly expressed in my patent of April, 1875, and see page 271.

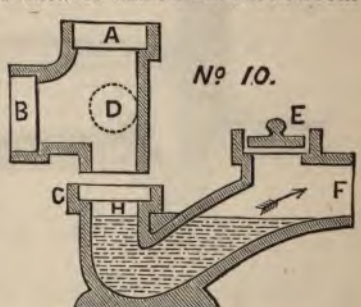


Fig. 467.

* *This was recommended in first edition of this work, pp. 216 and 218, published A.D. 1876.*

*ante.* The examination eye E on the outer end of trap is in my patent of May, 1877. This Fig. 467 trap is termed No. 10 Buchan's Trap.

Fig. 468 shows the latest improvement upon, or modification of, the Buchan trap. It is known as No. 8 trap. While the well C is about $4\frac{3}{4}$ in. diameter when the inlet and outlet ends B and D are 6 in., the top fresh-air inlet and inspection opening A is larger, viz., 9 in. in diameter. This gives more scope for inspection and cleansing, and allows the head of a man to be put in to look along the inside of the drain coming into the trap to see if it is all clear, and no cement sticking up at any of the joints, and no tools, or bricks, or stones, &c., left inside the pipe to choke it. This style of trap can be had in various sizes.

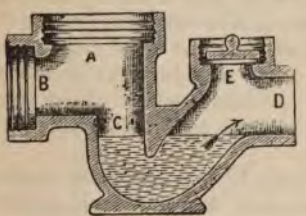


Fig. 468.

Fig. 469 is sketch of a No. 8 Buchan's trap *in situ* with

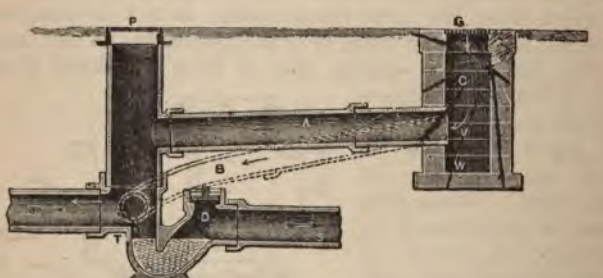


Fig. 469.

the fresh-air inlet grating G, several feet to one side of the trap. P is a strong cast-iron metal plate set in an iron frame, for getting access to the well, or house-side, of the *trap.*

*Fig. 470 is* sketch or ground-plan of the same trap, with *side fresh-air inlet* at G, and with blow-off pipe J attached to *the outer eye* D of the trap. F is an examination or access

eye, for getting at the inside of the ventilating drain and bottom of the blow-off pipe J. H is the drain coming from the house.

In Fig. 471 is shown the ground-plan of a house, and indi-

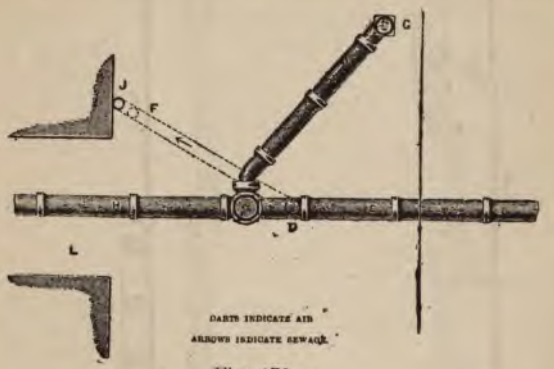



Fig. 470.

cating in detail the fittings now used in executing the drainage of a large house—say a country mansion—upon improved principles, and showing two different ways of carrying out the ventilation of the drains. At the back of the house the ventilating air-current in the drain is shown as going *the same way as the water-flow*, the blow-off for the drain being at D.

At the front of the house the ventilating air-current is shown as going in the opposite—and, as yet in practice, more customary—direction, from the water-flow, the blow-off being at B. The writer has executed the work satisfactorily in both ways.

In Fig. 471 we will suppose the house stands east and west, with front to the south. In that case the manhole at the south-west corner contains both a 6-in. No. 6 or No. 8 Buchan's trap J in two pieces, and also a single branch access-pipe K. This access-pipe has a strong iron lid, sealed down with lime and a thin coating of cement on top of the lime. The small outer eye of the trap is also sealed down with lime.

*The trap* and the access-pipe are better to be both laid or *set in Portland* cement concrete. The fresh-air inlet to the

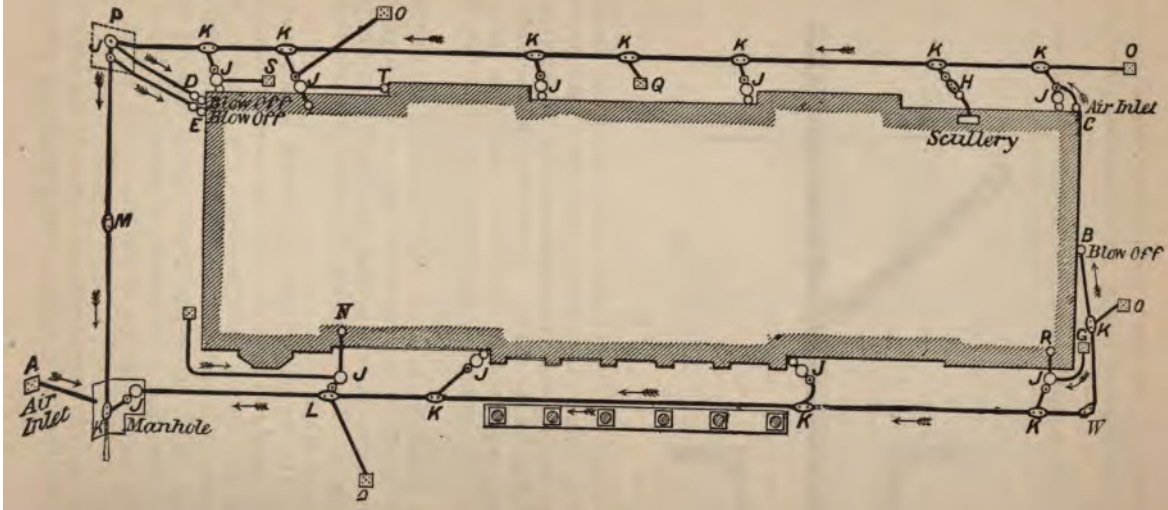

P
O
K
J
S
T
Q
H
D
E
Blow Off
Blow Off
Scullery
Air Inlet
C
M
B
Blow Off
N
R
G
A
Air Inlet
Manhole
L
W

Fig. 471.

trap and drain along the front of the house may be at A, on surface of the ground, through an iron grating, say 10 in. square or so. In some cases the side fresh-air inlet may be by a 4-in. iron pipe set up at end of house 7 ft. high or more, and near F. The trap J in the manhole prevents all aerial communication between the drain going along the back and the west end of the house and the drain along the front of the house.

When the lid K in the manhole is lifted, the water from both drains is seen uniting and passing on. This pipe here may be 7 in. diameter, or if it has a good fall of an inch or more to the yard from the manhole 6 in. may do. Both main drains coming into the manhole may be 6 in., or partly 6 in. and partly 5 in.; some of the branches being only 4 in. L is a 6-in. double-branch access-pipe. N shows position of the soil-pipe in a large mansion house,* which delivers into the No. 2 Buchan trap J. This trap has an 8-in. iron access-plate above it, the fresh-air inlet grating being round the corner at F, as shown. The two traps, J J, on each side of the main entrance, are supposed to be 4-in. No. 2 Buchan traps for rain-water pipes. R may be either a soil-pipe or a bath or basin waste-pipe, with fresh-air inlet at G. W is an access-bend; O, a little farther along, is a box-trap with slop-stone for surface water, as are all the gratings marked O. B is a 4-in. strong iron blow-off ventilating-pipe, painted with redlead inside to prevent rusting up. It should have a 4-in. access-eye with iron lid at its foot, as indicated for D and E blow-offs.

The access-pipes K, L, and M, which have strong moveable iron lids, enable the interior of the pipes to be viewed at any time, to see that they are all clear and clean inside. They are also highly useful in case of chokage.

At P, Fig. 471, there is another 6-in. No. 2 Buchan trap, with the drain from the back of the house delivering into it sideways. This trap may either be set in an inspection chamber, or manhole, or not, according to its depth. If it be less than 3 ft. deep, and in easily and readily dug-up soil, a manhole may be unnecessary, or merely optional;

* At "Stracathro," the residence of James Alex. Campbell, LL.D., M.P., the relative positions of two of the soil-pipes and their foot air-pipes are as shown at N and F. They have been there since 1884, *working quite satisfactorily* and void of offence. So with other *side fresh-air inlets for drains* and soil-pipes at many other houses, mansions, *&c., applied as per* F, G, or S.

hence it is indicated merely in dotted lines. It will be observed that a side-pipe leads off at an angle from each of the two vertical openings of the trap. The one off the outer eye of the trap leads to the 4-in. or 4½-in. iron blow-off pipe E, which ventilates the main drain or sewer beyond all the traps. The other pipe leads to the 4-in. or 4½-in. blow-off pipe D, which ventilates the drain going along the back of the house. The fresh air in this latter case enters at C, which may either be an iron pipe set up about 7 ft. high or more, or an iron grating at ground level. In the latter case the inlet may be fitted with a self-acting valve to let air in, but none out.

As indicated by the small outer circles at D and E, it is useful to have a 4-in. eye near the foot of the blow-off pipes, which eye is closed with an iron lid and lime, so that access can be got at any time to the foot of the blow-off pipes to see if they are clear, or to stuff them at foot temporarily when smoke-testing the drains.

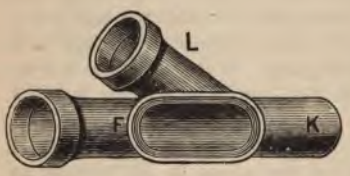



Fig. 472.

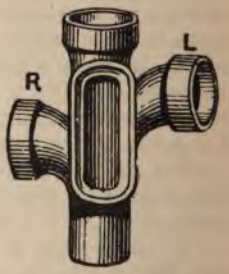



Fig. 473.

When the blow-off is at the lower end of the drain, as at D, both openings on the top of the trap are closed, each by a round moveable iron lid, the smaller or outer one being most securely sealed down.

S is a side fresh-air inlet on the ground for the No. 2 Buchan trap, J, for a water-closet soil pipe. T is either a 3-in. iron pipe acting as fresh-air inlet or a rain-pipe, the trap J in this case serving for a wash-basin and bath.

H is a Buchan's grease trap for the scullery sink. Near the air-inlet C at head of drain there may be a rain-pipe

delivering into either a 4-in. No. 2 Buchan's trap or a Field's flushing tank.

Fig. 472 is an enlarged view of the single-branch patent Buchan's access-pipe, shown at K in Fig. 471. The longitudinal opening on top is closed *in situ* with the strong iron lid shown in Figs. 451, 452 *ante*. In this case the branch L, Fig. 472, is to the *left*. Of course, the pipe can be had with the branch to the *right*, and also with two branches as at L in Fig. 471. By having the access-opening where the branch or branches join, we see into not only the main drain, but also the branch drain coming into it, which is often very useful.

Fig. 473 shows an access-pipe with rounded branches R and L (= right and left), one on each side, to serve for branch drains coming towards the main drain at a right angle.

Fig. 474 shows a Buchan's access-bend. In this case the bend is said to be to the left. The circular opening has a strong iron lid of suitable shape to go inside its bent longitudinal receptacle R.

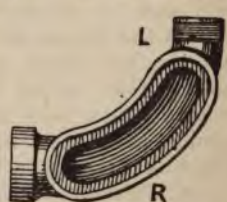


Fig. 474.

In closing down the lid this must be so done as that it can be easily lifted again without hurting the pipe, consequently it is best to use some lime first, and then a skin of cement on top of it. In some cases sand would do in place of lime, with a skin of cement above the sand; or red-lead putty may be used.

Some architects and sanitary engineers have advocated the use of an access-opening on the top of each drain-pipe, or of having the entire upper half of the pipe in pieces (the *pipe* being thus like the letter U with a bonnet), so as to get at the interior of the joint of each pipe with the hand; but, as may be seen by a glance at Fig. 475, this is quite unnecessary. Supposing it were desired, or really necessary, to get at the inside of each joint with the hand, this can be done in a tradesman-like manner, as in Fig. 475, by having each alternate pipe an access-pipe. The spigot end of the intervening *pipe* L being got at from the access-opening D, *while the faucet* end of L can be got at from the access-*opening* C, *each* access-opening giving access to two joints.

It is not really necessary, however, in general practice to have the access-openings so close (only 4 ft. 6 in. or so apart), as shown in Fig. 475.

To have them about 10 ft., 15 ft., 20 ft., or 25 ft. apart, or according as the branches come in, as shown in Fig. 471 *ante*, is much more sensible.

It would, generally speaking, be a pure waste of money to have an access-pipe for every second pipe, as shown in Fig. 475; while as for the notion of having the drain-pipe of houses, &c., laid in two halves, that would be to throw

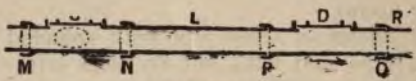



Fig. 475.

away a lot of cement, while making a very weak pipe; and with such an enormous amount of jointing all along both sides of the top, as well as the joints, of the U-shaped pipes and the lids, there would be far more scope for aerial leakage than in the way I recommend, while the drains so laid would, as a whole, be much weaker, and, in my opinion, much more liable to get out of order and leak than if laid as indicated in Fig. 471.

Fig. 476 shows vertical cross-section of Buchan's improved egg-shaped pipe with longitudinal ribs A A. The space between the ribs may be filled in with Portland cement or concrete for greater strength where the ground is soft, or an extra strong job wished. The intention of the egg-shape is to make the pipe more self-cleansing than the round ones, especially for sizes above 6 in. diameter. The outer line in Fig. 476 indicates the faucet of the pipe.

Fig. 476.

Fig. 477 shows longitudinal section of the improved pipe with raised bead A A, all around the *spigot end* of the pipe, for the purpose of centring said *spigot end* better in the faucet of the next pipe, as shown at B B, and so leaving a more equal space all round for the cement. This pipe is also made and supplied by Messrs. J. and M. Craig, Kilmarnock. In jointing drain-pipes with

cement, the joint would be more secure than it often is if it were more the practice to wash or brush the outside of the spigot end of the one pipe and the inside of the faucet end of the other with a brush dipped in clean water; then

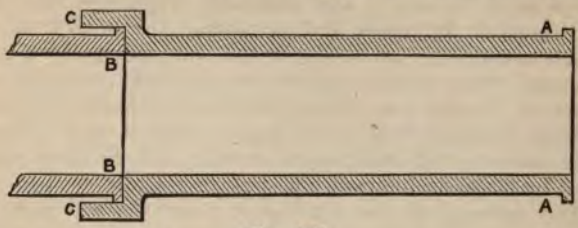



Fig. 477.

before putting in the one pipe into the other, put a little cement into the inner end of the faucet at B B all round.

When the entering pipe is pushed home some of the cement will likely protrude inside of the pipe; this is immediately scraped off, of course, with the scraper in ordinary use for that purpose, before the cement has got time to set or harden.

We have been illustrating how to execute drainage work in the way safest for the inmates of the house; Fig. 478

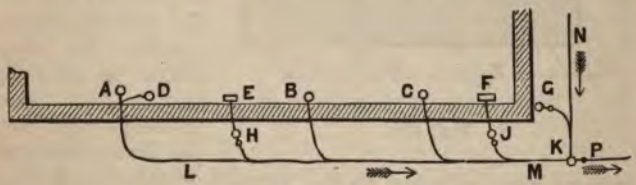



Fig. 478.

shows how the work should *not* be done if it can be avoided. In this case A, B, and C are water-closets, all with their soil-pipes in direct communication with the drain L M. D is a bath or basin, whose waste-pipe delivers into the soil-pipe of the closet A. E is a basin or sink, the waste-pipe of which *is disconnected* from the drain by the trap H. F is the *kitchen sink* with a grease-trap J. E and F are therefore *all right, so is* the rain-pipe G with its 4-in. Buchan's trap.

K is a No. 2 Buchan's trap, with two inlets for the drains M and N and the one outlet P to sewer.

Now this plan is partly right and partly wrong—what I condemn is allowing the smell of the drain to go up the soil-pipes A, B, and C, and especially when said soil-pipes are inside of the house, and permitting the smell from the closets A and B to get access to the soil-pipe of closet C, or the smell from closets C and B getting back to soil-pipe of closet A. In this case, should fever be in a house, it is more difficult to really isolate the patient than if each soil-pipe were disconnected and trapped outside, and the drain ventilated by a special blow-off pipe put up outside.

The delivery of the waste-pipe D into the soil pipe A is also faulty. It would be more correct to have this waste-pipe—whether for bath or basin—carried down *per se*, and with a trap at its foot for itself as per Fig. 410.

While re-arranging this chapter I came across the following plan, Fig. 479, newly made for improving the drainage of a building, the drains of which were badly choked up, and damaging the property. What I objected to in it was the use of No. 1 Buchan's Traps in place of the No. 2, and with the grating above the trap. Then, on the old drain, there were openings right over the drain, with gratings or iron bell-traps above, through which the children could put sticks, &c., into the drain; these openings were repeated again. The pipes along the sides of the building were waste-pipes for sinks, and with several sinks to each waste-pipe. As all these waste-pipes were to again join the intended-to-be improved new drain, I considered such a plan *to be behind* the age in 1894, and worse especially when *sanitary* authorities are condemning such work daily.

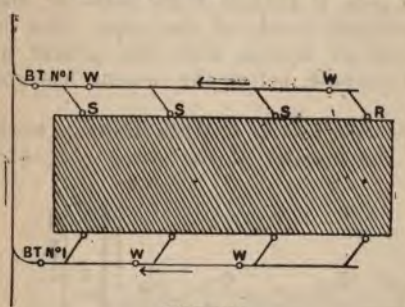



Fig. 479.

*Fig. 480* shows how the work should be done in order to *prevent the* children either getting at the disconnecting *traps to* choke them, or getting injured themselves.

In the first place, the disconnecting traps are No. 2 Buchan traps, and with an iron plate on top, the fresh air for the two main ones to be either by side inlet gratings on ground level as at A A, or by means of a pipe for each, set up at each corner of the building. The other traps at foot of the waste-pipes—if put in—to have also side fresh-air inlet, either on ground, as shown in Fig. 480, or the gratings may be fixed in the centre of a solid stone in the face of the wall. The gratings W for the surface water are to have a sand trap below each to keep back smell and prevent chokage of the drain. V V are the blow-off ventilating pipes for the drains. Should the extra trap at the foot of each waste-pipe be omitted, then the special blow-off pipes would be unnecessary. Yet, even with these omissions, Fig. 480 plan would be much better than Fig. 479 plan.

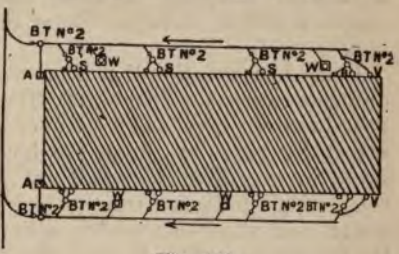



Fig. 480.

Attention to details is as much necessary in getting satisfactory results from drainage work as in watch-making.

When it is wished to be so done, drains may be flushed automatically at certain intervals by a siphon-pipe having its upper end placed inside a cistern, which cistern is filled either by a ball-cock, turned upside down and with a ∩-pipe attached to it, or in place of the ball-cock a cottage closet-cock with lever may be used, and with a loaded copper ball in place of the iron weight; there being also a small regulating stop-cock branched off the side of the supply-pipe to the ball-cock. This small stop-cock is to allow the water to dribble into and fill up the lower portion of the cistern so far at the desired rate: when the cistern is so far—say three-quarters—filled by a small stop-cock, the rising water gradually raises the ball of the larger cock and opens it, which after running full bore for a minute or so, charges the siphon.

The siphon *once* started must be regulated to empty the *cistern quicker* than the supply-pipe can fill it, so as to *allow the supply*-cock to shut. A large regulating-cock on

the supply-pipe to the cistern would therefore be useful. A 1¼-in. siphon-pipe would be a serviceable size. An overflow pipe, which would both act as a warning-pipe if the siphon not working, and to prevent the cistern running over, would be useful. If the drain is flushed once a day, or only once in so many days, the best time to do it would be about 9 P.M., so as to have the drains clean during the night while sleeping. In some cases a rain-water flushing cistern would be useful, or Roger Field's automatic flushing tank.

I may here mention that when executing, in 1879, certain drainage work for the Clyde Trust at Dalmuir, I there introduced the Sectional System of trapping and ventilating Street Sewers; *e.g.*, upon the bottom of a short branch sewer in one of the streets I put in one of my large disconnecting ventilating traps to lock off gases from the main sewer, and allow this branch sewer to be ventilated *per se*, the fresh air entering through the trap to lower part of the sewer; and one of my patent exhaust induced-current fixed ventilators being placed upon the top of a 4½-in. diameter iron pipe carried up above the chimneys from the top of the higher end of the sewer, a current of fresh air was thereby caused to flow through the sewer—the foul air blowing off high up above the roofs. The branch drains from the various tenements leading into the street sewer had my traps upon them, and the gutter gratings in street had also water-traps placed below them, so that no foul air could pass up through said gutter gratings.

Thousands of people have often been annoyed by the foul smells from the sewer coming up the untrapped gratings so often placed at the edge of pavements, and I believe many people have been poisoned thereby, and especially children, who will often be seen playing over them and inhaling the deadly fumes, all unconscious of their danger. The stink issuing from untrapped gratings at the edge of the pavement at some coast towns in summer is often most abominable; but whether in the town or at the coast this should be stopped, *and no gutter gratings should be allowed in streets without having a proper trap below each.*

*Figs.* 481 and 482 are vertical sections of two forms of *"gully"* or water-traps in use for placing below gutter *gratings* in streets, &c. Both are generally round in the *body.* The former is sometimes styled a "Box-trap." A

considerable amount of space exists in the bottom A, of each

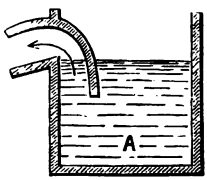



Fig. 481.

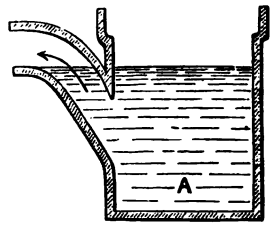



Fig. 482.

trap, where sand, &c., may accumulate for some time without interfering with the working of the traps. The sand

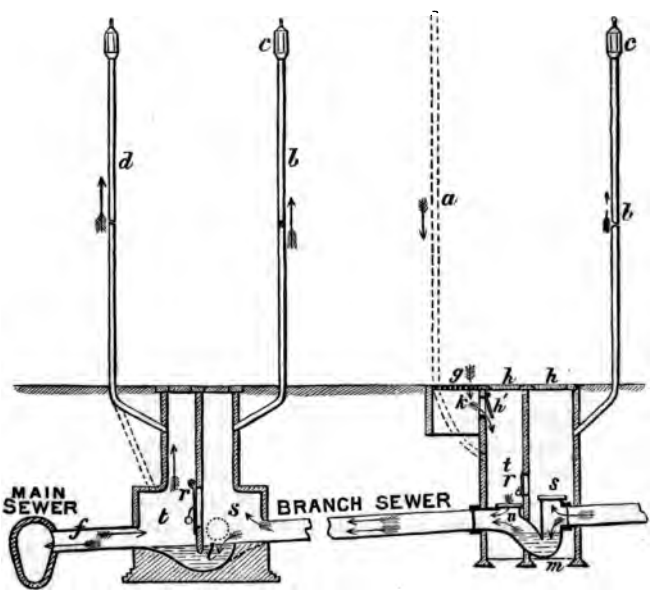



Fig. 483.

*requires to be* removed at intervals, of course, or else the *trap would choke* in the course of time.

*Figs.* 483, 484, and 485 show plans of the Section

System of trapping and ventilating Street Sewers, as referred to in my patent of March 22nd, 1883. In Fig. 483 the pipe *d* and the two pipes *b b* indicate high-level blow-off ventilating pipes for different sections of the sewer.

These pipes are supposed to be carried up to above the roofs of most convenient houses, the higher the better. In the drawing the air current and water current are shown as both going in the same direction, but where it is found to work better the air may be allowed to go the opposite way from the water. I show both ways in my 1883 specification.

In Fig. 483 the fresh air may either enter through a strong iron grating *g* (which may have or have not a self-closing valve *h*, to let fresh air in, but no foul air out)

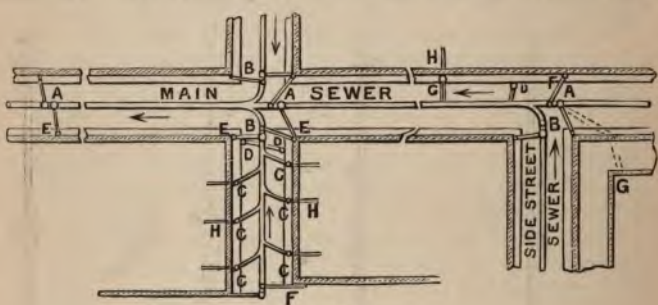



Fig. 484.

placed on the ground-level, or, where preferred, the fresh-air inlet may be by a high-level inlet-pipe, as indicated at *a*, and which may or may not have an inlet cowl at top. One of my fixed induced-current exhaust ventilators *c* is shown as placed upon the top of the foul-air outlet ventilating pipe *b*. The object of this system of trapping and ventilating street sewers is to prevent foul-air from the sewers coming out at the street level. In case a trap should ever choke there is shown a valve *r*, which the rising water can *push* open and so get away. The dotted circle at *s* indicates *a side-street* sewer coming into the trap, so that, as shown *in Fig. 485*, one trap may serve for three different street *sewers all* coming into one trap.

*Fig. 484* is a ground plan of sewers showing a separate

trap for each side street, as well as traps at any desired distance from each other on the main sewer, so as to prevent smells from main sewer going up any of the side streets, as wished, and also prevent smells or air in the main sewer from going any farther along said main sewer than is desired.

All the drains H from the houses, &c., are shown to have a main disconnecting trap C; D indicates trapped gully gratings, E blow-off ventilating pipes. G indicates that if wished a strong iron blow-off pipe may be put in through sunk flat or otherwise of a house or warehouse and carried up the back of said house to above the roof. I prefer, however, that the blow-off pipes for the sewers should not enter the inside of any building at all, and especially if that building is a dwelling-house.

Fig. 485 is a modification of Fig. 484, showing fewer

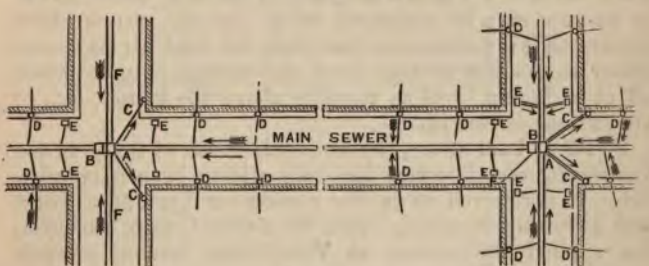



Fig. 485.

traps on the sewer, and indicating that one trap may serve for two, three, or more streets. In this drawing the ventilating air current is also shown as going in the same direction as the water, which would often be the best way, especially where there was not much fall and the water current strong.

This plan might often be best also where the prevailing wind blew in the same direction as the water went. In other cases, where the prevailing wind blew the opposite way from the water flow, then it might be better to make provision for the air current going in the opposite direction *from the water flow*. The arrows indicate the water-flow, *the darts the air*-currents.

D, *Fig. 485*, indicates Buchan's disconnecting traps put on

between each house, &c., and the sewer. E is gully trap at edge of pavement for the gutter water. C is blow-off ventilating pipe; A is Buchan's disconnecting trap in street in one of the styles shown in Fig. 483. B is the outer end of the trap. There are strong iron access covers at the level of the street, for access to either end of each trap. *g*, Fig. 483, shows the fresh-air inlet grating to one side of the access opening or manhole of the trap, with sand or rubbish-pocket below the grating. In other cases either the usual strong open iron gratings may be used, or special gratings with rubbish catch-pit below, as shown in Figs. 486 and 487.

F, Fig. 485, indicates side-street sewers going into the trap on the main sewer. Where there is sufficient fall, the water going into the trap from the sewer behind it and from the side sewers may be made to fall into the trap, but where there is not sufficient gradient for that, then this fall or cascade may be dispensed with. In the system above illustrated it is understood that while the fresh air may enter either from a low or high level, the foul air is to be blown off at as high a level as possible above the houses, &c., or above their chimneys.

So far as I am aware, the sectional system of trapping and ventilating street sewers has very seldom been adopted as yet. It is referred to in *The Builder* for April 28th, 1888, and following numbers. Mr. W. Santo Crimp, surveyor, has applied the system at Wimbledon, having recently isolated several miles of sewers in that district, where he found that the ventilating air current often went down hill with the water-flow, as I had anticipated, and found in my own experience.*

A short paper on "Ventilation of Street Sewers," read by me at the Sanitary Congress of the Sanitary Institute of Great Britain, held at Glasgow in September, 1883, will be found at page 264 of Vol. V. of "Transactions of the Sanitary Institute of Great Britain."

In this paper I described three different improved ways of ventilating the street sewers, starting with the understanding that in each case the drains of all houses and other *buildings* were to be isolated from the sewer air by a proper

* *But as the general result of his experiments he states that "in sewers the wind is by far the most powerful agent producing movements of sewer-air."*

disconnecting trap. This being done, the sewers, as they generally are, may then be ventilated by using the iron gratings in the middle of the street as inlets, and put up high-level blow-off ventilating iron pipes, with induced-current fixed ventilators upon them, above the houses to act as outlets. These blow-off pipes may be attached at bottom to the outer eyes of my No. 2 traps, as shown at L, Fig. 461, and E, Fig. 417. The gully gratings at the edge of the pavement are to be trapped.*

Another plan was to close up the ventilating gratings in the street, and have a number of high-level ventilating-pipes put up to above the roofs of the houses or other buildings, so many to act as inlets and so many as outlets.

The third plan was the sectional system of trapping and

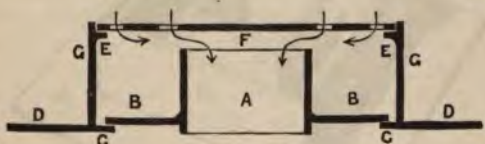



Fig. 486.

ventilating the sewers illustrated in Figs. 483, 484, and 485.

Figs. 486 and 487 show vertical cross sections and perspective of improved ventilating iron gratings, with provision for preventing sand, stones, or sticks falling into or being put down the ventilating and access shaft above the

* A most important paper in connection with this subject was read before the Philosophical Society of Glasgow, in December, 1877, by Dr. James B. Russell, Medical Officer of Health, Glasgow, entitled "On the Comparative Prevalence of Filth-diseases in Town and Country," from which we draw the welcome intelligence for dwellers in towns that if the drainage and water supply of towns are properly carried out, and as with proper intelligent supervision they easily might be, then the disease and death-rate would fall very much. Even with all its drawbacks, Dr. Russell says, "that in regard to diphtheria, enteric fever, and cholera, a citizen of Glasgow runs much less risk of dying of these diseases than an inhabitant of Caithness or Aberdeenshire, or almost any other rural district in Scotland you choose to name!" It seems from this that Nature will have it so that filth, even *although mixed up* and flavoured with the most stolid sanctimoniousness, *will yet* produce disease and premature death. Fast-days and *prayers—with* work undone and duties disregarded—being as much *"vain oblations"* now as they were two thousand years ago.

trap, and so falling into the trap. A s square or round opening for ventilation, situated right over the ventilating opening on the house side of the trap. The fresh air enters

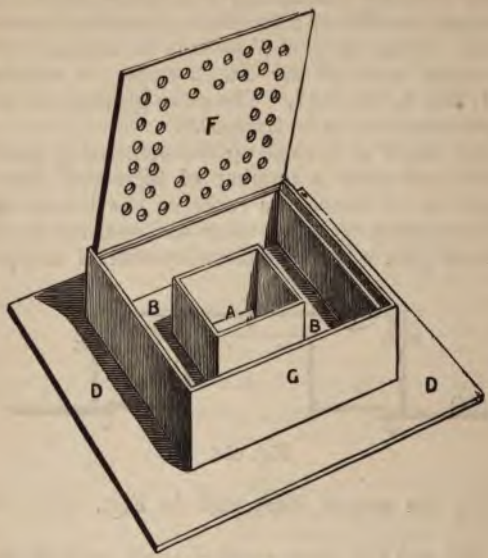



Fig. 487.

from the holes in the iron cover F, as shown by the darts. To get access to see, or cleanse out, the trap, the cover F is first lifted, and then the interior portion B B may also be

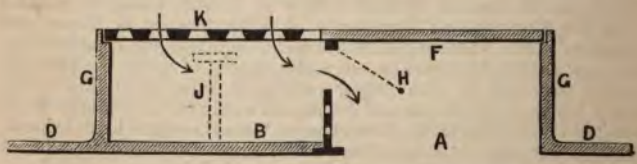



Fig. 488.

*taken out.* G is the outer vertical casing of the iron frame, *which may* be either square, round, or longitudinal. D is *the iron flange* or sole. Iron-framed gratings in this style

may be made any size, say from 8in. square or diameter and upwards for drains, and in stronger style and larger for sewers.

These iron gratings and frames may be had from Messrs. Walter Macfarlane & Co., Saracen Foundry, Glasgow, or Messrs. George Smith & Co., of the Sun Foundry, Glasgow, as also Fig. 488 style. In Fig. 488, which shows longitudinal vertical section of strong iron frame GG with movable iron lid K F, which lid or cover is half grating and half iron plate, there may be used a self-acting valve H, which is intended to let fresh air pass freely into the drain or sewer, but to close against any air, fresh or foul, trying to get out. There may be an iron bottom B below the grating, either fixed or movable. If movable it may have a handle J. Or this bottom part B may be awanting and a deeper hole left in the ground. The top cover of the frame K F may be in either one or two pieces. The grating K is placed to one side of the opening A in order to prevent sticks, sand, or stones falling through the grating getting into the opening A. This style of grating and cover may be used above

Fig. 489.

Fig. 490.

Fig. 491

*the traps or access* openings of either drains or sewers. *The breadth of* Fig. 488 cover K F may only be about half *its length.*

Figs. 489 and 490 are illustrations of the Buchan No. 1 and No. 1C Induced-Current Fixed Ventilator for soil-pipes, &c., referred to on pages 275, 302, 323, and 324.

Fig. 491 is style of ventilator used for ventilating ships and yachts. Sometimes this style is preferred for certain styles of buildings.

For illustrations of and descriptions how to fit up exhaust ventilators on roofs of churches, halls, schools, &c., see the author's text-book on "Ventilation," No. 271 of Weale's Series.

A good deal has now been said as to how to carry off the liquid drainage of a house; while the sanitary authorities of our cities and towns are using all their influence to have the work in this relation done well, there is room, however, for them and all concerned to see that something more and better should also be done in the way of making provision for carrying off the aerial drainage of our houses. We ought to see that the vitiated air is carried off as well as the dirty water.

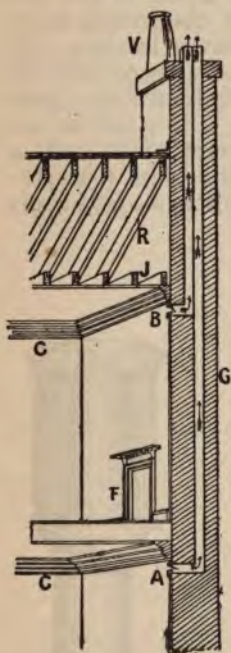


Fig. 492.

Fig. 492 is a simple plan towards this object. G is the gable of a house with the vents and fireplaces in it. Each vent will be about 9 or 10 inches in diameter inside. Now, between two vents two or four 4-in. or 4½-in. diameter iron pipes—they may be galvanised sheet iron riveted at the seams—might be put in with outlet from each apartment near the ceiling, or just below the cornice, as at A and B, Fig. 492. At these outlets A and B, a self-acting valve box, with silk valve in it, might be put in to let the air from the room into the pipe, *but to close* against any attempted back or down draught. *Fresh air is* let into the room by the window or *otherwise.*

*Fig.* 493 is plan of two ventilating-pipes coming up

between two vents, each ventilating-pipe being from a separate apartment.

Fig. 494 indicates four ventilating-pipes coming up from

Fig. 493.

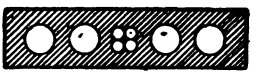


Fig. 494.

four apartments, one vent and one ventilating-pipe from each. All in the same gable.

I do not enlarge upon this subject here, as it is dealt with more at length in my treatise on "Ventilation," No. 271 of Weale's Series.

## CHAPTER XXXIII.

### The Smoke-test for Drains.

It may be both interesting and useful to give some particulars here of the origin or introduction of the now-so-much-used machine-applied smoke-test for drains. Up to about the middle of the eighth decade of this century, there was no recognised or known system in general use for examining defective drains except exposing them. It appeared to me that this state of matters was open to improvement, more especially as in houses I was examining myself I wished to know the state the drains and sanitary pipes were in without disturbing them.

As I was aware, especially when the soil-pipes went up inside of the house, that a current of air generally passed into the drains from any opening made into them from outside of the house, especially if said opening were made or existed upon the inner side of a disconnecting trap, it occurred to me that if smoke were passed into the drain and the top outlet of the soil-pipe or other outlet pipes closed, that then, if leaks existed in the drains, &c., the action of the chimneys if fires were on would draw out this smoke into the house. Upon experimenting I found this to be the case. At first my *modus operandi* or style of applying the smoke into the drain was rather crude, viz., by suspending or placing burning straw or brown paper into the drain.

This was primarily done by me at the end of April, 1875, when fitting in the first of my then newly-patented disconnecting drain traps upon the drains of a property in Renfield Street, Glasgow. I soon found there was room for improvement, and so tried soiled cotton waste suspended down the vertical opening on the house side of my disconnecting trap. This gave better results and did pretty well,

especially where the leaks were bad, and several fires on in the house. It did not do so well, however, for empty houses. I therefore got a fanner to blow air into the drain above the suspended cotton waste, and was considering how to improve this when I was called in to see if I could cure a plague of rats which infested Dr. Samuel Moore's house here, and which he had been fighting against with a fumigating machine by which the fumes of sulphur paper were blown into the rats' holes, and so scared them away for a time. I trapped and sorted the drains, and also discovered a passage or rat-run from the next house, and after closing up the hole in the gable with cement the rats disappeared; and as Dr. Moore had no more use for his fumigating machine I bought it from him, finding it would do very well for applying the smoke-test to drains with, only in place of using sulphur paper, which was expensive, I used the cotton waste I had been using before with some sulphur or brimstone mixed with it.*

Fig. 495 shows sketch of this fumigating machine; the material for fumigating with, or for producing smoke, being placed in the round vertical chamber. The fan is in the round side chamber with the nozzle. To this nozzle a piece of india-rubber tube, about 1¼-in. diameter, or so, is attached, for conveying the sulphur fumes or smoke into the place to be fumigated, or, as I used it, into the drain. The large driving wheel is attached to the spindle of the fanner by a band made of ⅜-in. spliced hempen cord or rope.† This "Fumigator" was patented in 1871,

Fig. 495.

* The author did not patent this system of testing drains and soil-pipes by smoke, so that all and sundry might freely use it.

† I have found these hempen cords rather expensive, paying six shillings and nine pence nett the half-dozen for them, carriage extra. Mr. John Todd, rope manufacturer here, tells me he can supply them in quantities spliced, at about twopence each; but he recommends a *round cotton rope band* as better. It costs about threepence each. As *an improvement* upon the cord band, Mr. Peter Fyfe, Sanitary Inspector, *Glasgow*, has introduced toothed wheels for driving the fan.

April 28th, No. 1,137, by Mr. S. S. Bateson, of Mayfair, Middlesex, and the first duty of £50 was paid in 1874; but the £100 duty due at the end of the seventh year was not paid, and so on May 10th, 1878, the Patent was advertised in the Commissioners of Patents' Journal as void. The machine, as a producer of smoke for drain-testing, is open to improvement, as, in my experience, unless the waste is carefully manipulated, it sometimes goes into flame, and the result is invisible gas instead of visible smoke.*

Mr. Bateson, in his A.D. 1871 specification, did not refer to his machine as a producer of smoke for testing drains, as we now do, but states that it was to fumigate or destroy vermin and noxious insects, or to disinfect sick-rooms or hospital wards, or to perfume apartments, halls, or theatres. He died in 1879. Shortly after I began to use the machine-applied smoke-test for finding out defects in the drains and soil-pipes, &c., of houses, the late Mr. Kenneth Macleod, Sanitary Inspector for Glasgow, recommended it, and one of his staff, Mr. James Dobson, invented a smoke machine of his own design for testing the drains of houses, and used it privately.

The first application of the smoke-test by the Sanitary Department of Glasgow for the public, as recorded in the books, was on 20th February, 1882, several years after my introduction of it. Mr. Macleod had publicly recommended it, however, in 1880. Mr. Dobson, and Mr. Peter Fyfe, now the sanitary inspector for Glasgow, have lately patented a smoke-testing machine which works by water-power.

Fig. 496 gives sketch of this machine in the act of being used above a 6-inch Buchan's No. 2 disconnecting trap, to blow smoke into the house drain. E is the combustion chamber; K is the fanner; D the blow-pipe from the fanner to the combustion chamber; Q is the water-cock for driving the fan; it is connected by means of a ½-in. or ¾-in. india-rubber tube, attached at one end at Z, and at other end to one of the cold-water taps in the house.

* It is somewhat heavy also, the smallest one I have, without its india-rubber tube, weighing about 37 lbs. Mr. Dobson's hand-worked machine, with india-rubber tube and wooden box to carry machine in, weighs 25 lbs. in all. Burn and Bailie's, with tube but without wooden box, weighs 27 lbs., with the box it weighs 47 lbs. Dobson's newer water-power machine, on the injector principle, weighs 5½ *lbs., while the* ½-in. india-rubber pipe I have for conveying the water *to it weighs* 13¾ lbs.

Fig. 495 style of smoke machine, as also Fig. 497 style, require some person to drive them; but Fig. 496, being driven by water, can be left for a considerable time working away itself, wherever there is plenty of water with sufficient pressure—about 50 lbs. per square inch, or less does very well—to drive it. The amount of water used is not great, as it has to pass through a fine nozzle before

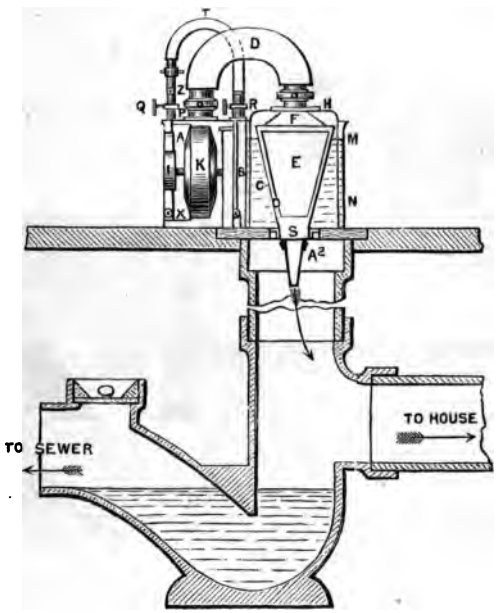



Fig. 496.

impinging on the turbine I. The machine has also an injector arrangement, in order to put extra pressure on when wished. Further information will be got from the patentees.

Fig. 497 is a style of hand-worked smoke-testing machine, which I have used of late and found serviceable. It was patented in 1884, Oct. 23rd, No. 14,056, by Mr. Macdonald, of the firm of Messrs. Burn & Baillie, plumbers and brass-founders, Edinburgh. It is shown as seated upon the ground, and blowing smoke through the tube M into

the top of a Buchan's No. 2 trap, and from thence into the drains in or around the house. L is the cover over the combustion chamber, which chamber is filled with soiled cotton waste ; J is the handle which works the bellows ; K is a stop-cock for shutting when the bellows is not being worked, in order to prevent the smoke or heat from the combustion chamber getting back into the bellows. The outside of the combustion chamber is filled with water,

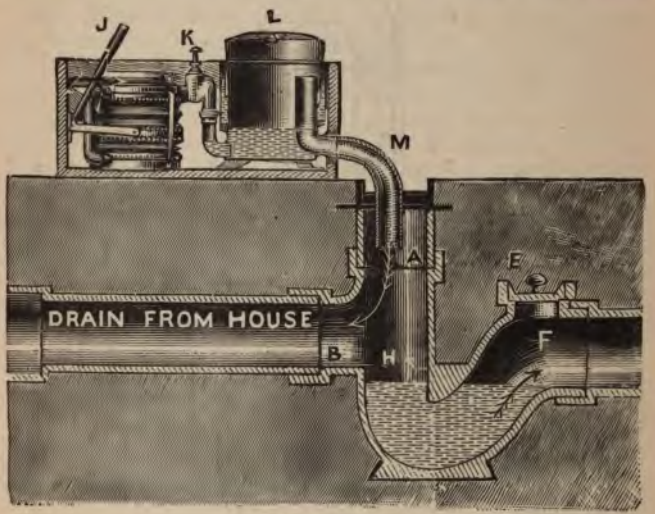



Fig. 497.

and so a water-tight joint is formed when the cover L is put on.

Fig. 498 is a vertical, longitudinal section of smoke-testing machine, designed by Mr. J. G. Kirtley, St. Thomas Street Works, Sunderland.

A A is the outer case made of copper, with an inner case C C which forms a space which is filled with water ; the inner case being a little higher than the outer. At the *bottom of the* inner case a false bottom, G, rests, which is *full of holes.* On this false bottom, G, the smouldering or *burning waste* to raise the smoke is placed. The lid, B B, *with its deep* all-round rim reaching to the bottom of the

water-receptacle, is then put on, and being worked up and down by the hand grasping the handle H, the smoke is pumped from the smoke chamber W, through the india-rubber tube, D, into the drain. E is an india-rubber bladder which can be put into the trap or drain-pipe and inflated by air pumped into it through the pipe J. F is the mouth of the pipe D, pointing into the drain. I have used Kirtley's machine for testing the drainage of buildings, and it answered very well.*

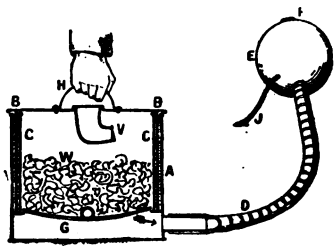


Fig. 498.

Instead of, or supplementary to, the smoke test, the water test is sometimes used; blocking up the lower end of the drain, and then pouring or running water in at the higher end, see if the water remains in the pipes or gets away where it should not.

When smoke-testing the drains of houses the tradesmen or parties doing it must watch, and not asphyxiate or suffocate the baby or any of the other inmates of the house. The canary or parrot need not be killed either.

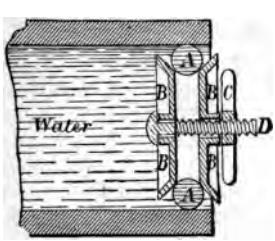


Fig. 499.

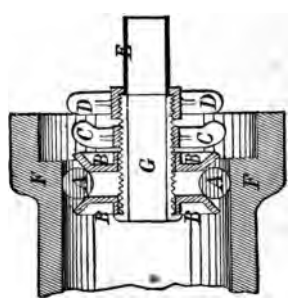


Fig. 500.

Fig. 499 shows the plug invented by Mr. Francis Botting, sanitary engineer, Baker Street, London, for plugging up

* In both Burn and Bailie's and Kirtley's machines the wave motion *imparted to the air* by the pumping action has the effect sometimes of *breaking the seal* of the water traps, and especially where there is *little seal*. *This has to be guarded against.*

drain-pipes when either the water-test or smoke-test is applied. B B are two discs of either wood or iron, bevelled at the circumference, as shown. When these discs are screwed towards each other the solid ring of india-rubber A is pressed tightly against the circumference of the pipe, and so a tight plug is formed.

Fig. 500 shows a modification of this plug, suggested by the author, in which, instead of forming the screw of a solid bolt, it is made of a tube G, through which the smoke from a smoke machine may be applied when testing the drains.

The use of peppermint and paraffin oil for testing drains has been tried, but as these tests only depend upon the sense of smell—of which sense various people are considerably deficient—the smelling test has had to give way to the smoke test, as the latter appeals not merely to the nose but also to the eyes.

Since the introduction of the smoke-test sanitary authorities have taken more interest in, and exercised beneficial supervision over, the drainage of buildings. In various cities and towns it has for some time back been the law that the drains of new buildings are not to be covered up until they have been examined, smoke-tested, and passed as right by the authorities. This is bound to be of great benefit to the community.

It is also customary now for many people to have the drains of the houses they intend to occupy smoke-tested before they go into them, and afterwards smoke-tested yearly—say before coming home from the coast.

When disease of a kind, possibly due to bad drainage, breaks out in a house, the medical adviser often insists upon the smoke-test being applied to the drainage system, and possibly with the result, as has often happened, of serious faults being disclosed where none were supposed to exist.

The institution of vaccination by Dr. Edward Jenner in 1796, the invention of chloroform as an anæsthetic by Sir James Y. Simpson in 1847, and Sir Joseph Lister's antiseptic treatment in surgery, are instances among many of what has been done by members of the medical profession *to prevent* and palliate human disease and suffering. *Perhaps some* gracious historian in the next century will *acknowledge* that the introduction of the smoke-test for *drains by a* tradesman was a step in the same direction.

# CHAPTER XXXIV.

## Water Regulators or Governors, and Gas Stoves.

Attention is here drawn to a new water regulator invented some years ago by Mr. William Foulis, gas engineer, Glasgow. The object of this regulator is to control the supply of water in mains so as to maintain a constant outlet pressure, under varying conditions of inlet pressure or outlet consumption. *E.g.*, if the reservoir were 200 feet high above a certain district, then by the insertion of this new regulator the pressure could be reduced to only 100 feet, and so on, as desired. A great improvement in these valves is that even the largest sizes may be worked by weights of a few pounds.

Fig. 501 is vertical section of one arrangement where F is the inlet, G the outlet from the governor, A is the valve, and B the piston attached to it; C is the pipe communicating with the arrangement shown in Fig. 502. The pressure on the top of the valve A balances the pressure under the piston B, and the valve adjusts itself until the balance of pressures is obtained. The inlet pressure acting on the bottom of the valve A and top of the piston B is neutralised, and has no influence on the action of the governor.

The means of obtaining the necessary pressure under the piston is shown in the arrangement in Fig. 502. It consists of an elongated piston or ram P, about ½ in. in diameter and 6 in. long, working in a cylinder G. In this ram a recess is cut. C is a pipe leading to the underside of the piston of the valve, F is a communication with the inlet of the valve, and G communicates either with the outlet or above ground. A small hole, D, through the ram communicates the pressure to its underside. The ram is continued

through the top of the cylinder, and may be loaded to any desired extent.

The regulating arrangement in Fig. 502 from its small size may be placed in any convenient position—*e.g.* in the

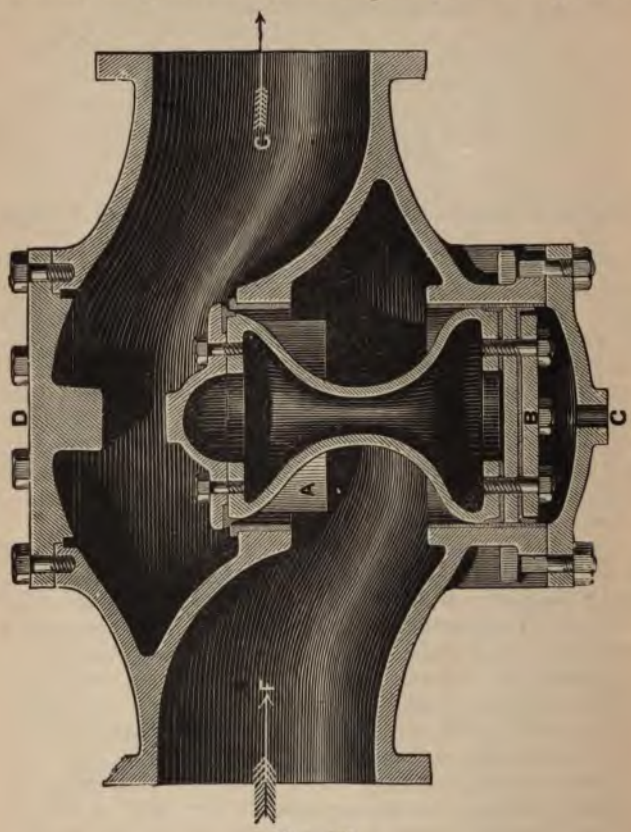



Fig. 501.

pillar of a lamp as shown in Fig. 503—the governor itself being placed underground on the line of main, at any distance from the regulating arrangement. Such a regulator as above described should be very useful in a town or city with various levels, to prevent waste of pressure upon the

low levels, and allow full pressure only for the high levels.

Fig. 504 is vertical section of a small-sized regulator, the intention of which is to reduce the pressure in service pipes to houses in cases where the pressure is stronger than is

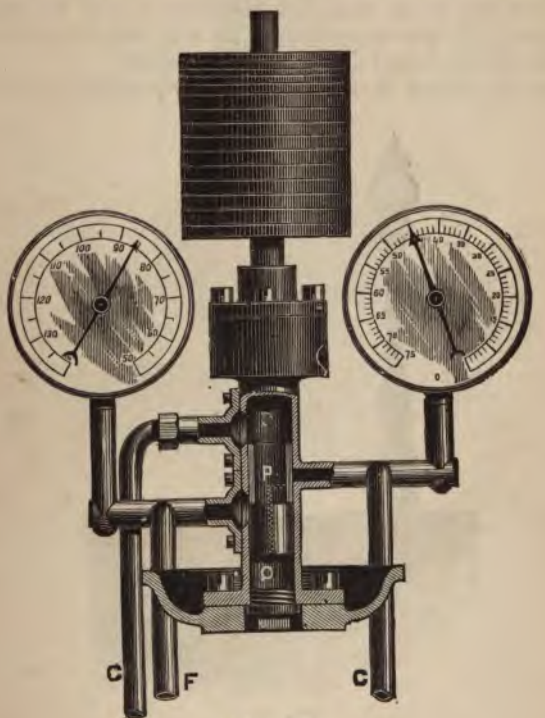



Fig. 502.

either necessary or is wanted, and so help to save injury to the pipes and fittings from extra high pressure.

I have not seen any of the large governors working yet, but I am told they are doing satisfactorily where they have been applied. It will require some time to show their real value. I saw some experiments with the small one, Fig. 504, *showing its action* as a reducer of the pressure. Hitherto

stop-cocks have been used, as per page 189, to serve at one and the same time as shut-off cocks and as regulators to check excessive out-flow while the water was running; but these stop-cocks, although half shut, did not reduce the pressure in any degree, when the water ceased running. If Fig. 504 would serve as stop-cock, regulator, and reducer of the pressure all in one, then its value would be greatly enhanced. It was suggested to try one with a screw-down spindle attached, and also with an air vessel.

Fig. 505 shows Ross's patent water-pressure regulating

Fig. 503.

and reducing valve. The pressure on the house side of the valve is regulated by adjusting the sliding weight W, on or along the lever L. This valve is useful in protecting the fittings from excessive pressure at night, or otherwise. One *I saw working* one day seemed to do very well. It was *placed on the* ¾-inch lead supply pipe coming into a tene*ment from the* street. The valve is made by Messrs. William *Ross & Sons,* Glasgow.

Fig. 506 is sketch of an improved Gas Stove—entitled the "Regenerator"—lately invented by Mr. Foulis. It is made in two styles as per vertical sections Figs. 507 and 508. The latter (the A pattern) has a heating air chamber,

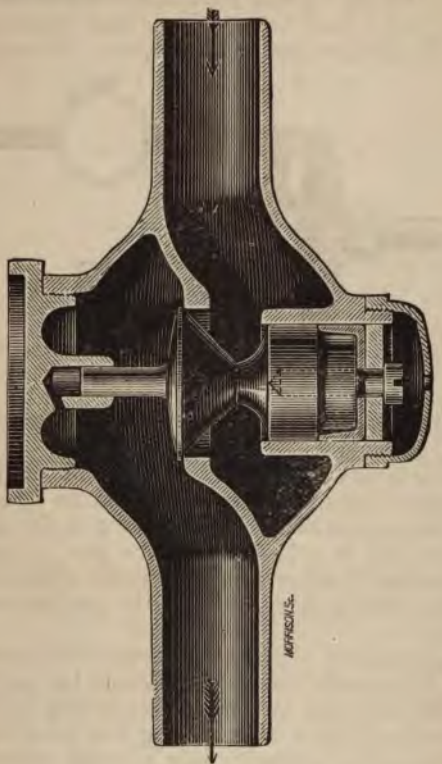


Fig. 504.

F, between the furnace or fire and the outer metal casing which the former (the B pattern) wants.

In Fig. 508, it will also be seen that the outlet for the waste gas fumes is low down near the floor at E, whereas the outlet for the gas fumes in Fig. 507 is near the top at D. For this reason I prefer to use Fig. 507 style of stove,

and especially where the vent or outlet pipe from the gas stove has not an exceptionally good up-draught. Fig. 507 is the cheaper style and I think the healthier also.*

I put one of the Fig. 507 stoves into the billiard-room of Mr. M. G. Neilson's house, Brentham, Pollokshields, N.B., and after it has been on for some time the room gets so warm that the gas has to be lowered. It was intended

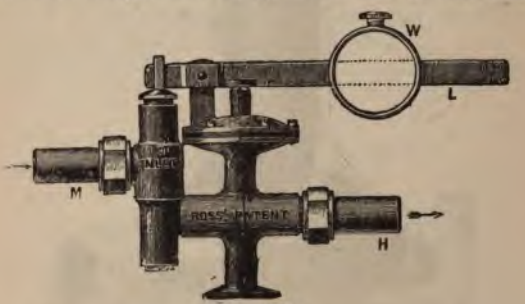



Fig. 505.

to put in two stoves, but I recommended that one should be tried first, which is found quite enough.

B in both figures is the combustion chamber into which the gas flames deliver. Above B there is an irregular fret-work of firebrick, which is intended to give the appearance of a bright coal or coke fire when the gas is lighted. As the combustion chamber B is surrounded with firebricks, a very strong heat is sent out after the gas has been on for some time.

When a gas stove is used in a room, there is much more necessity to provide outlet ventilation to carry off the vitiated air than with the ordinary open fire, for the latter has generally a large or wide opening into the vent, whereas the gas stove has generally only a small outlet equal to about a three-inch or four-inch diameter pipe. This being so, supposing a "Regenerator" gas stove to be fitted into a room in place of the register grate B shown in diagram, Fig. 509, then have either one or two ventilating pipes put *in as per* the "Air-pipe C," which air-pipe C may either have *its inlet opening* at D as shown, or it may be above the *ceiling*—*say* in the centre of the room. In other cases the

* *The makers* are R. and A. Main, Gas Cooking and Heating *Engineers*, Argyle Works, Glasgow. Also the Carron Company.

outlet may be by the pipe H, Fig. 509, or its equivalent. A gas stove badly fitted into a room may make the room warm, but at same time it may act like a slow-poisoner,

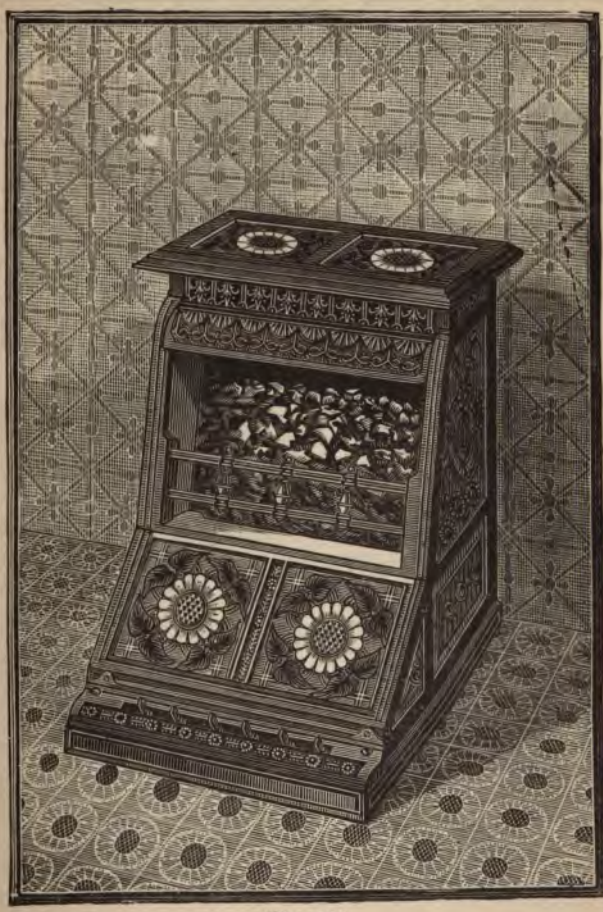


Fig. 506.

*while a good* gas stove fitted into a room that is sufficiently *ventilated will* make it warm, comfortable, and healthy.

*It is often* highly dangerous to leave a warm room an

stand in the draught of the open outer door speaking to departing friends, and especially on a cold day. Many people have brought painful illness and even death upon themselves by so doing. A highly accomplished young

Fig. 507.

Fig. 508.

lady friend of the Author's lost her life, after a few days' severe illness, in this way.

A great variety of gas stoves for heating and also for

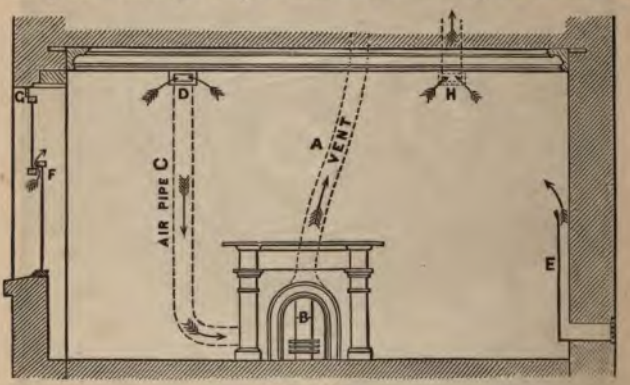



Fig. 509.

*cooking* are made by other makers, such as Thomas Fletcher, *of Warrington*; John Wright & Co., of Birmingham; Smith *and Wellstood*, Glasgow, &c., &c., while a number of the gas *companies or* corporations now show gas stoves at their offices.

## CHAPTER XXXV.

### Registration of Plumbers.

In closing this new edition of Plumbing, it will be both interesting and useful to give a short sketch of the rise and spread of the present great movement for the National Registration of Plumbers. The Worshipful Company of Plumbers of London has taken the lead in this, and spared neither money nor pains in striving to make it a success. The public start of the movement may be said to have taken place at the Congress of Plumbers from all parts of the kingdom, held at the International Health Exhibition, London, in October, 1884. This Congress was held to consider the best means for protecting the public, in regard to plumbers' work in connection with house sanitation, and also to consider what practical steps should be taken to raise the status of the trade.

The chairman of the meetings, at the "Healtheries," was the then Master of the London Plumbers' Company, who previously to this had been striving to do something to advance the craft for the good of the public, and amongst other things the suggestion was made to confer the membership of the Plumbers' Company, as a premium and diploma, on craftsmen who proved themselves worthy of it, and which diploma would be a means of letting it be publicly known that its recipient was a qualified and worthy plumber. This contained the germ of a good idea but was too local for general application, hence the necessity for something wider in scope.

Apart from this it was felt by a few who took an interest in plumbing work, that the great International Health Exhibition of 1884, in London, should be utilised in order

to hold a National Congress of Plumbers at it to consider questions affecting the trade.

Mr. Arthur T. Dale, of the *Plumber and Decorator*, London, wrote to me in the summer of 1884, asking me to use my influence in getting up a meeting of plumbers in London during the Exhibition, and after thinking the matter over it seemed to me that if anything really practical and *permanent* was to result from a meeting of plumbers at the "Healtheries," some influential local person or body must be got to take the lead in the proceedings. The only body that I knew that could properly do so was the Worshipful Company of Plumbers of London, so in June, 1884, I wrote to the Master of the Company, mentioning that it was desirable to have a Congress of Plumbers at London during the Exhibition, and asking him to lay the matter before his Company to see if they would agree to take part in the Congress. He entered heartily into the idea himself, and a special meeting of the Wardens' Court being called, the idea was approved of by it.* The Company thereafter proceeded to take active steps to get up and organize the proposed Congress, which was most successfully held in October, 1884, the Master and officers of the Plumbers' Company attending and taking the leading part at the meeting, which lasted two days.

The opening paper read was by Mr. Ernest Hart, on "The Regulation and Registration of Plumbers; Facts in support of the Extension of the Existing Statute Law as to House Drainage." There followed papers by Mr. William Eassie, on "The Technical Instruction of Plumbers," by Mr. C. T. Millis, on "Technical Education for the Sanitary Plumber," and by Mr. J. W. Clarke and Mr. E. G. Mawbey on the same subject. A discussion followed in which a number of those present took part.† Other papers were

* I also communicated with a number of other master-plumbers in London and elsewhere—more particularly with Mr. P. J. Davies of London, and Mr. D. Emptage of Margate—who promised to aid the movement. The proposal was also ventilated and advocated in the Plumbing and Architectural Journals.

† A full account of the proceedings was published in book form—extending to 153 pages—by the Plumbers' Company. I see on page 41 *that in reference* to the value of water traps I am made to say, "*In spite of the* water, particles of gas remained which caused *disease.*" *That is* nonsense. What I said was that, "In spite of the *laboratory experiments*—which showed strong gases passing through *water—in practice* a good water-trap prevented the passage through

read by or for Mr. W. R. Maguire, of Dublin; Mr. F. Wells, of Worcester; Mr. John Smeaton, of London; Mr. P. J. Davies and Mr. E. Knight, both of London; Mr. Robert Smith, of Bermondsey Square; Mr. H. Webb, of London; Mr. W. P. Buchan, Glasgow; Mr. W. Poole, of Norwich; Mr. David Emptage, of Margate; Mr. T. H. Court, of London; and Mr. J. Bailey, of Grantham.

The Resolutions passed at the Congress were:—

1. "That it is the opinion of this Congress that architects should not include plumber's work in the builder's contract."

2. "That in the opinion of this Congress it is desirable that the apprenticeship system should be continued, modified, if necessary, to suit the improved course of technical education."

3. "That this Congress is of opinion that in the event of the establishment of Provincial Boards of Examiners of Plumbing Work, such Boards—

(1.) Should be affiliated with a Metropolitan Board.

(2.) Should consist largely of trained working plumbers.

(3.) Should be in connection with Provincial Schools of Plumbing."

4. "That in the opinion of this Congress the registration of master plumbers and journeymen is expedient."

5. "That this Congress is of opinion that it is expedient that the system of sealing or marking lead and solder of standard weight and quality be revived by the Plumbers' Company, and that the Plumbers' Company should be requested to consider whether the materials used in plumbers' work as substitutes for lead are suitable, and whether standards of quality for such materials could be advantageously fixed on and verified by a recognised mark."

it of the particular germs which caused disease, and also of sewage air or gases to do any harm." (Also see pages 287 and 290 of this edition.) On page 87, again, I am made to say, "Some of the best plumbers in Glasgow, while condemning the use of iron for soil-pipes, invariably use heavy iron for other purposes. I have never, however, seen anything wrong with any of these iron pipes." This should read, "While condemning the use of light iron pipes for soil-pipes, *invariably* use heavy iron pipes for that purpose. I have never *seen anything* wrong with these heavy (about ¼-inch thick) iron *soil-pipes.*" Should a new edition of these Proceedings be issued, the *editor might* kindly oblige by correcting these mistakes.

6. "That the Resolutions, Recommendations, and Conclusions set forth in the preceding papers be referred to the Plumbers' Guild, with a request that they will confer thereon with a view to take such action as may seem best."

The first of these Resolutions refers more to the London or English practice, as in Scotland it is customary to give the plumber's work directly to the plumber. The fourth Resolution, proposed by Mr. D. Emptage and seconded by Mr. Houghton, however, is the one we are particularly dealing with here.

At first this Registration was set a-going in the London district, but it soon overflowed that boundary and its aspirations became national. The Company, therefore, went out into the provinces, with the result that in Scotland, *e.g.*, the northern part of the kingdom has been laid out into six districts, viz.:—Glasgow and the West of Scotland; Edinburgh and the East of Scotland; Forfarshire, Fifeshire and Perthshire; Aberdeenshire, Kincardineshire and Banffshire; Inverness and the North of Scotland; Dumfriesshire, Kirkcudbrightshire and Wigtownshire.*

The first District Council in Scotland was the Forfarshire one, with its head-quarters at Dundee. The Glasgow and West of Scotland Council was established next at Glasgow, on January 9th, 1888, Sir James King, Bart., the then Lord Provost of Glasgow, in the Chair, and up to the end of 1894 there have been sent into it about 900 applications for Registration from both masters and men.

The popularity of the National System of Registration was increased by the circulation of what is known as the Plumbers' Catechism—covering the whole question of Registration—prepared by the late Mr. A. M. Scott, who was secretary to the District Council for Glasgow and the West of Scotland up to the time of his much-regretted death, on the 9th August, 1892, a few days after attending the Congress of the Sanitary Association of Scotland at Aberdeen. Mr. Scott has been succeeded in this secretaryship by his partner in business, Mr. Archibald Craig, M.A., LL.B. Alderman Sir Stuart Knill, Bart., past Lord Mayor of London, who has been Master of the London Plumbers'

* *Each district* council consists of an equal number of masters and men *and also of* public representatives. The latter generally including *the chief magistrates* and the leading members of the architectural, *medical, and engineering* professions.

Company for a number of years, has devoted much of his time to the furtherance of the Registration movement.

In England, in addition to the head-quarters in London, District Councils have been established for Manchester and district; Lancashire, Cheshire, and North Wales; Northumberland, Durham, Westmoreland, Cumberland, and North Yorkshire; also in Sussex, &c., &c. In all thirty-nine District Councils have been established in England.

Before the establishment of the various District Councils, a large number of plumbers were registered directly by the Plumbers' Company in London; such has been the case with a number of Irish plumbers, as well as with plumbers in both England and Scotland.

In Ireland there are now three District Councils. One for Ulster with its secretaryship at Belfast; one for Leinster and Connaught with Dublin for its centre; and one for Munster with Cork as the *locale* of its secretary.

At first, applicants for Registration were admitted on proof of having served apprenticeship, but it was intimated that after certain dates those applying would have to undergo examination in both the theory and practice of the trade. Technical Schools, were, therefore, inaugurated for the benefit of the younger members of the craft,* and have done much good. In alliance with these practical classes have also been opened, in especially-fitted-up class-rooms,† in which lead-working, pipe-bending, soldering in the shape of wiping and jointing, &c., are taught. At the Congress of Delegates from all the Scottish Plumbers' Registration Councils held at Dundee in 1892, a motion was passed to

* The introductory lecture of the Glasgow classes, which are under the control of the Glasgow and West of Scotland Technical College, was delivered by Mr. J. W. Clarke, Lecturer on Plumbing for the City and Guilds of London Institute, on October 10th, 1888, to a very large audience, Thomas Russell, Esq., of Ascog, one of the Governors of the College, in the Chair; there being present, amongst others, Alderman Knill from London, Past Master of the London Plumbers' Company, Professor Jamieson, M.I.C.E., Dr. Ebenezer Duncan, Dr. H. Dyer, C.E., and others. The local lecturer is Mr. David Fulton, R.P. The district council for Glasgow and the West of Scotland has given an endowment-grant of £20 to the class. Prizes have also been given by the City and Guilds of London Institute, and also by local parties for the best collection of illustrated notes handed in at the end of the session by pupils.

† *At Glasgow* the fitting up of the large practical class-room, including new iron-faced benches and tools, &c., cost fully £130.

the effect that applicants for registration who have been in all not less than ten years at the trade should be eligible for registration without undergoing examination provided they gave satisfactory evidence otherwise of their qualifications.

Municipal Sanitary Authorities, Architectural and Sanitary Associations, many of the leading architects and owners of property, have all evinced their sympathy with the movement; while the British Medical Association, at its annual meeting at Dublin, in 1887, passed a motion that in view of its bearing upon the health of the public the due registration of plumbers—in order to prevent incapable parties practising as plumbers—was a necessity. Up to the end of 1894 about eight thousand plumbers have been registered—about one-third being masters—all getting their diplomas from the London Plumbers' Company.*

A Bill to afford Parliamentary sanction for this Registration of Plumbers and to create a General Council which with the aid of the local councils will be charged with the promotion of the Technical Education of the Plumber and will exercise control over all whose names are on the official Register, is at present before Parliament.

This Bill has received the approval of the principal public bodies interested in sanitary improvement, including the International Congress of Hygiene and Demography, held in London in 1891, the Sanitary Association of Scotland, the British Institute of Public Health, and a number of the leading municipal corporations in the kingdom.

As a proof of the earnest spirit in which the movement is being prosecuted in one part of the country, it may be mentioned that the Scottish Councils have by joint labours produced a set of Model Regulations and Bye-Laws for the Plumbing and Drainage Work of Buildings.

* Further information regarding registration will be got on applying either to the Council in the district or to the Worshipful Company of Plumbers, 1, Adelaide Buildings, London Bridge, London. The Clerk of the Company is Mr. Wm. R. E. Coles, to whose indefatigable and *con amore* services the continued progress of the movement is largely due.

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